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Alphabetical Index of Advertisers
Page 16

Vol. 31 January 3, 1917 No. 1

Principal Contents

Page
Editorial ... 1
Prince Edward Car Ferry Terminals at Cape Tormentine, N. B. ... 3
Activated Sludge Experiments ... 5
Defects in a Concrete Sewer at St. Vital ... 6
Human Efficiency Methods ... 10
Bituminous Binders for Macadam Roads ... 11
Scientific Research in Relation to the Industries ... 14
Practical Hints for the Contractor ... 16
Mainly Constructional ... 18

Misleading Estimates on Public Works

Much criticism has centered around the new concrete interurban highway connecting Toronto and Hamilton. There seems, in some quarters at least, to be a prejudice against the work that has been done, and in the lay mind, which is unappreciative of the engineering aspects of the project, there exists a certain dissatisfaction with the results of the Highway Commission's labor, accounted for, no doubt, by the widespread reports of defects in the road surface. The newspapers have seemingly taken the opportunity to make a mountain out of a molehill. Vague reports of a few unassuming cracks were expanded into charges of indifferent workmanship and careless supervision. We have repeatedly pointed out, however, that the blame for any faults that may exist so far as construction is concerned can hardly be placed upon the shoulders of the engineers in charge. The practical opinions of widely experienced authorities seem to indicate that surface defects in the nature of cracks are inseparable from concrete roadways. This is the one objectionable feature for which apparently no specific or sure remedy has as yet been developed. In the light of similar experiences on the much more extensive concrete roads in the United States it would be only reasonable to expect that minor surface defects would be incurred. Indeed, it is a very difficult matter to lay concrete-faced roads without cracks developing at some time or other, and the examinations which have been made of the Toronto-Hamilton highway since the publication of the rumors referred to, together with the engineers' reports, show that this piece of work is well above the average, and the extent of the damage not so great as to cause alarm regarding the road's durability. Indeed, giving due consideration to the war-imposed conditions under which the work was executed, we have no evidence that the engineering is open to criticism.

* * *

The one feature that, we believe, has caused prejudice against the way the work has been handled has been the lack of providing a suitable estimate of cost before funds were asked for. To all appearances the method of procedure was simply to ask for money on the basis of a pure guess as to the estimated expenditure. No effort seems to have been made to enlist engineering services or to analyze the local conditions, and, from a careful survey, to secure a figure that would at least approximate within a few per cent. the actual cost. To date the cost has been around 100 per cent. greater than the estimate, and it is no wonder that kicks are being registered. Nothing is so liable to create distrust, cause prejudice, or injure a scheme's usefulness as a guesswork estimate that may or may not, and usually does not, approach the true cost.

No reflection or insinuation is intended to be cast upon any of the authorities responsible for the development of the Toronto-Hamilton road, nor, indeed, must too hasty a criticism be directed against the management of the scheme. The errors in estimating are lessened, if possible, in this case when consideration is given to the frequency of such procedure. There is a vast waste of money every year, due to undertaking more than there are funds to meet. And the lack of funds is due to hasty, inaccurate guesses at costs. Guesswork estimates may persuade taxpayers to vote bonds, but when an investigation shows that the promises of the promoters are not subject to fulfilment at the cost estimated, so much dissatisfaction and distrust are caused as to interfere with good roads development.

* * *

A most flagrant example of the extent to which misleading estimates on public work may go is brought to our attention at this moment. In a Toronto newspaper, under date December 28, there is displayed in its advertising columns a bold statement, unsigned, but, of course, vouched for by the paper in question, that 200,000 horse power of electrical energy can be developed at an expenditure of $4,000,000 to $5,000,000, which indicates that power will be produced at the unprecedented capital cost of $20 to $25 per horse power. Such a statement is so grossly misleading as to demand vigorous criticism. That such a figure should appear in the public press is beyond comprehension, when there is no precedent whatever that would lead to the conclusion that hydro-electric power has been, or can be, produced anywhere on the American continent for much less than $100 per horse power. This statement is issued even in the face of Sir Adam Beck's repeated declaration that $9,000,000 will be the expenditure necessary for the production of the

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first 100,000 horse power; in other words, $90 per horse power will be the capital cost. Such a misleading estimate, so publicly flaunted, is calculated only to create distrust in the furtherance of the project. The completion of the scheme will serve to verify the figures that installations heretofore have proven acceptable. Guesswork estimates such as this will injure rather than promote public ownership of electrical schemes in Ontario. It is the duty of the Commission, therefore, to trace the source of this statement and to correct the wrong impression that has been given, if it wishes to enlist the future service and sympathies of the citizens of this province.

The detrimental effects of misleading estimates are absolutely as true in regard to any other kind of public work. The results so far as road work is concerned have already been mentioned. Nothing is so much calculated to arouse opposition to engineering development as guesswork in arriving at costs. There is a great fallacy in supposing that guesswork pays. It does nothing but retard future development.

The Engineer's Opportunity for Patriotic Service

ENGINEERS representing practically every phase of industrial and scientific work in Canada met at the Engineers' Club, Toronto, on Thursday evening, December 28, to talk over the possibilities in the way of formulating some plan whereby those members who are unable, for any reason, to render service to the Empire in the regular way, may still be of value in the great war by furthering at home the work of munition making, or by giving their services in some technical capacity, so that the general war work may be carried on more efficiently and expeditiously.

Discussion centered around ways and means of using the varied engineering abilities represented at the meeting and many promising suggestions were offered, which will be followed up promptly. The business of the evening culminated in the formation of a strong executive composed, for the most part, of the chairmen of the local branches of the various engineering societies represented in Canada. Mr. Alfred Burton, who acted as chairman at Thursday evening's meeting, will continue in that capacity, with Mr. Wills Maclachlan as secretary.

The first meeting of the new executive was called for Tuesday evening, January 2, in the Engineers' Club. Members of the Canadian engineering profession, wherever they may be located, or in whatever work engaged, are urged to give careful thought to this matter and send in suggestions to the secretary. There is undoubtedly much that trained engineers can do at home and there is a universally expressed eagerness to do it. Just what particular work there is that each, or any, of us can do is what this new committee will endeavor to find out.

The opinion was generally expressed on Thursday evening that as soon as the Toronto organization could determine that its existence was justified, suggestions for the formation of similar committees should be made to other cities and provinces. The idea underlying this suggestion was that every engineer in Canada may have an opportunity to lend his aid. The prospect of some ten thousand trained men of the engineering profession working together to help correlate and perfect the war organization at home is fraught, we believe, with tremendous possibilities. Not the least effect would be the moral influence such action would have on our men at the front, who would hear with decided satisfaction of such a practical movement.

Canada's Help Wanted for the Development of Water Powers in Russia

THE Canadian Government Commercial Agent at Petrograd, Russia, has advised the Superintendent of the Dominion Water Power Branch that the new Imperial Water Ways Department of the Russian Government has now under review a number of very important water power projects in various parts of Russia, and has suggested that it is not unlikely that the Chief Engineer of the Imperial Water Ways Department would wish to avail himself of Canadian engineering experience in the design and construction of hydro-electric developments, and also of the manufacturers of all kinds of equipment, electrical, hydro-electric and mechanical, required for a complete water power development.

The Dominion Water Power Branch is undertaking to inform the Canadian Government Commercial Agent at Petrograd of the names of all Canadian industries which turn out equipment employed in water power development, also of the names of Canadian contractors who have constructed hydro-electric undertakings throughout the Dominion. The Secretary of the Canadian Society of Civil Engineers, Montreal, is arranging to furnish as complete a list as possible of Canadian engineers who have designed and constructed power plants. The Superintendent of the Dominion Water Power Branch is endeavoring to collate the necessary data to be forwarded to Petrograd with the least possible delay, and while it is possible that direct communications may be made to the better known Canadian contractors and Canadian manufacturers of power equipment, it would be advisable for readers of the Contract Record to communicate direct with this official at Ottawa.

The Dominion Water Power Branch deserves credit for its foresight in making known, by every possible means at its command, the great work accomplished by Canadian engineers and contractors in power development on this continent. Russia should prove a tremendous field for Canadian engineers and business men in power development activities, and every possible effort should be made to take advantage of the present situation. Some months ago at the initiative of this Branch, several prominent Russian engineers made a visit to Canada to see for themselves what Canadian engineers and business men have already accomplished in power development. One of the engineers returned to Russia immediately, and it is probable that the urgent request made to the Superintendent of the Dominion Water Power Branch for information, as set out above, is a direct result of this visit.

Apparatus for Testing Fireproofness

The United States Bureau of Standards has installed a very complete apparatus for testing the resistance of structures and materials to fire, especially as regards walls and partitions. From the results of the tests it is possible to determine whether a fire will be confined to one room of a building long enough to permit firemen to reach the same and attack it with their appliances, or whether it will spread rapidly through the building and to adjoining structures.

Prince Edward Island Car Ferry Terminals at Cape Tormentine, N.B.

By Kenneth S. Pickard, B.Sc. (McGill), Assoc. Mem. C.S.C.E.

THE following article is a brief description of the work of construction of the Prince Edward Island car ferry terminals at Cape Tormentine, N.B., now under contract. The contract, for this work is held by O'Brien, Doheny & Co., of Montreal, and a sub-contract for all the rock work was let to the Sackville Freestone Company, Ltd. The writer has charge of this sub-contract for the rock construction work at Cape Tormentine.

Ever since Prince Edward Island entered Confederation the subject of transportation between the mainland and the island has been a serious question. The Government undertook to provide communication winter and summer. They have had a great deal of trouble in fulfilling this compact, as steamers have been tied up for a considerable length of time nearly every winter. The car ferry from Carleton Point, on Prince Edward Island to Cape Tormentine, on the mainland, was proposed shortly after the Conservative Government came into power in 1911, and these points were chosen as terminals on either side of Northumberland Strait.

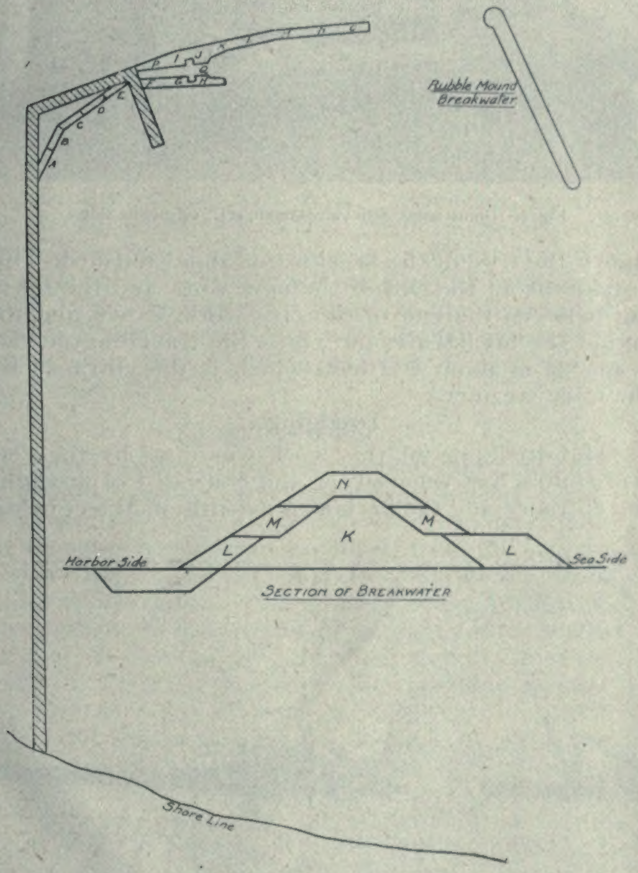


Fig. 1—General plan of Prince Edward Island car ferry terminals at Cape Tormentine, N. B., now in course of construction.

General Description of the Work.

The attached plan of the general scheme shows the outline of the work; the shaded portion shows the old pier constructed by the Public Works Department, and the unshaded lines show the new work now being constructed by the Department of Railways and Canals.

Cribs A, B, C, D, and E are timber cribs constructed of creosoted pine below water and native timber above. These cribs were constructed to provide an easier curve for getting trains around to the ferry landing and also to provide a berth to load lumber and other commodities on other ships than the car ferry. The space between these cribs and the old wharf was filled in with earth. Cribs F, G, H, P, I, J, K, L, M, N, and O are of the same construction as A, B, C, D, and E, and provide a berth for the ferry steamer "Prince Edward Island." A heavy pile fender is provided for the boat to lie against and also to prevent shock when docking. Between cribs F, G, and H on one side and cribs P, I, J, on the other, the steel transfer bridge for running the cars on and off the boat is placed. This is raised and lowered by means of a hoisting engine.

The rubble mound breakwater is placed across the end of the crib work and 400 feet distant from it. This is to form a harbor and also act as a protection and hold the ice in the winter time.

Fig. 2 shows a general view of the berth where the ferry steamer is to lie. Overhead the steel construction for raising and lowering the transfer bridge is seen in this photo. The pile fender which has a hardwood facing is just in front of the steel work on both sides. This is to form a protection for the boat and piers from shock when the boat is docking. The umbrella roof for the landing of passengers from the boat to the passenger cars which will stand on the track alongside, is shown just to the right of the transfer bridge. The wall shown on the extreme right of the photo is a sea-wall 10 ft. wide and 6 ft. high, to serve as a protection from the sea during severe storms.

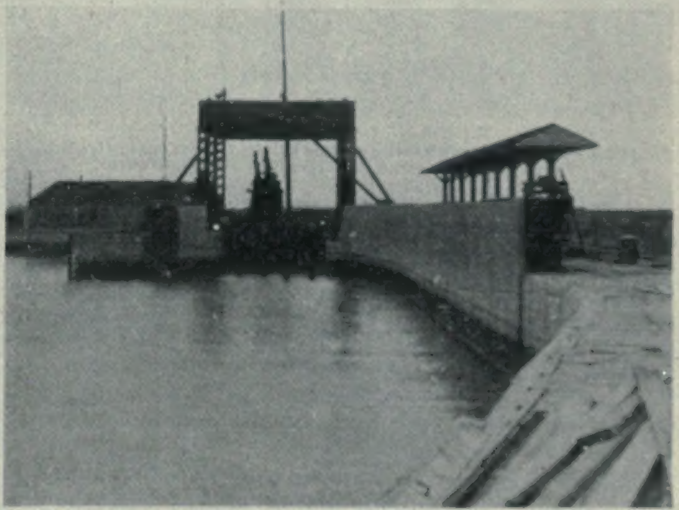


Fig. 2.—General view of ferry berth, showing steel transfer bridge, pile fender, canopies and sea wall.

The Timber Crib Work Construction.

The cribs are constructed of creosoted pine below low water and native timber above. The cribs are built up on a sort of grid or raft for three or four courses and then launched. They are built of 12 by 12 timbers.

The cribs are then finished up to low water level, or about two feet above it. They are then towed into position and held there by anchors and lines attached to capstans on the cribs. The cribs are then filled with rock from scows and from cars run out on the trestle constructed on the cribs. This is seen very clearly from Fig. 3, which shows several cars run out on this trestle and men throwing rock off into the cribs. The crib is there shown built up to about two feet above low water. After being filled up to low water the bents for supporting the trestle work are taken off and the cribs built up to their proper level.

Rock Work Construction.

This consists of the filling of the cribs shown in Fig. 3, the talus or protection of the sea side of the cribs and the rubble mound breakwater. The crib fill stones are small stones, which one man can handle, and are taken to the work on cars and dumped off by hand. The centre or core of the breakwater and also the core of the talus consists of stone, 50 per cent. of which must be over half a ton in weight. The larger part of the covering stone, known as small rubble, is over three-quarters of a ton in weight on the harbor side and one ton in weight on the sea side. This is shown in section L on the attached plan. Section M consists of large rubble stone, which must be over five tons on the sea side and over three tons in weight on the harbor side. Section N is the capping stone, which must be over four tons in weight on the sea side and three tons in weight on the harbor side. These stones are laid with the least dimensions showing on the face.

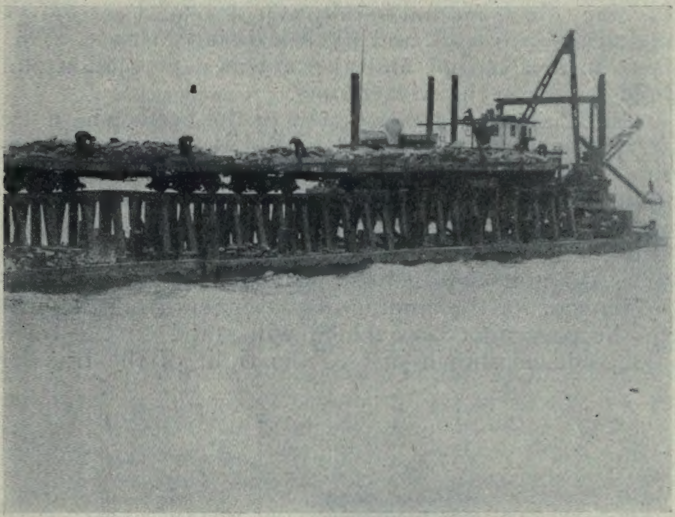


Fig. 3.—Filling cribs with rock delivered by cars run out on trestle work. The cribs shown here are built up a little above low water.

All the stone for the talus and breakwater is taken from the quarry of the Sackville Freestone Company, Ltd., at Sackville, a distance of 36 miles by rail. It is then loaded on scows by means of a loading derrick, which is built on a pile foundation alongside of the old pier. It is then towed out to the required places and unloaded in the different ways described in the following: In starting to build the core a special dump scow is used, which was built with a watertight longitudinal bulkhead and valves in one side, so that by opening these valves water can be let into one side of the scow. A false bottom was also placed in this section of the scow or tank, raised up so that the top of the floor was a little above the water line when the scow floated light. By this means after dumping the load the water would all drain off when the valves were left open, thus doing away with a lot of expensive dumping. Fig. 4 shows the scow fastened in position by means of lines. The water valves are open and the scow is settling to one side.

After the core is dumped up to a depth of about 8 feet below water the dump scow can no longer be used, and the finishing process has to be done first with a floating derrick (Fig. 5), and later by means of the travelling derrick shown in the same photo. This photo shows the core of the breakwater about finished. This is taken from the end of the new work and the opening between the end of the crib work shown and the end of the breakwater on which the travelling derrick is placed is about 400 feet, which is the entrance for the ferry steamer.

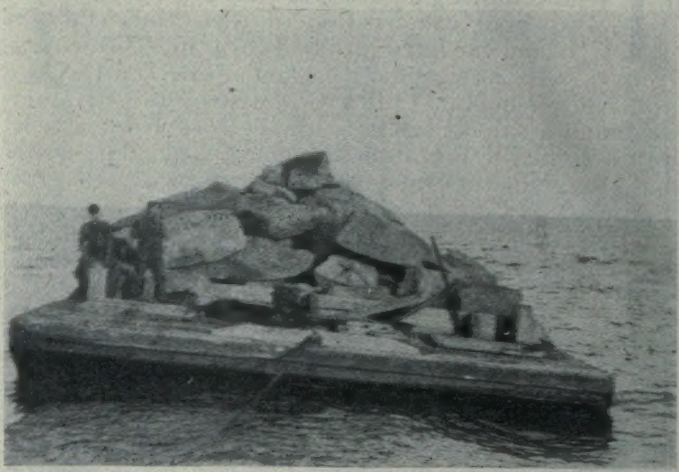


Fig. 4.—Dump scow, with valves open, settling on one side.

Dredging.

The dredging for this work was done by the general contractors themselves, and consisted of dredging the entrance and the harbor to a depth of 20 feet below low water. The berth for the steamer was dredged a few feet below this.

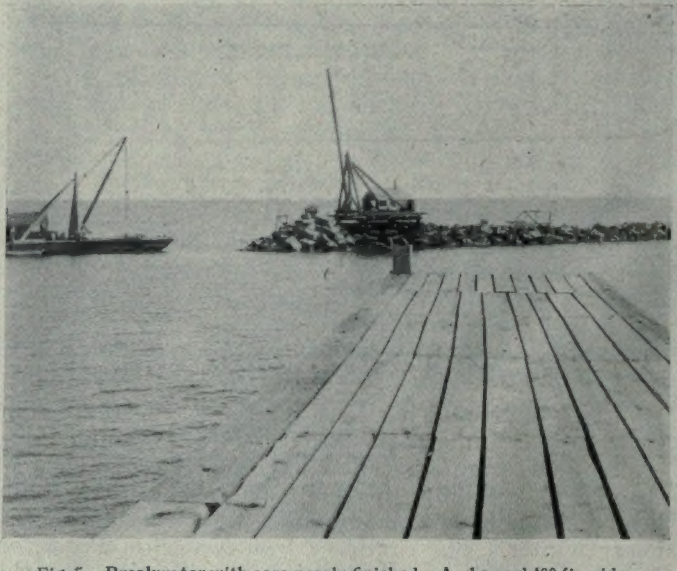


Fig. 5.—Breakwater with core nearly finished. A channel 400 ft. wide is shown between the breakwater and pier in the foreground.

Difficulties During Construction.

The rough weather and heavy seas met with at Cape Tormentine were the cause of serious difficulties to the contractors. It was often impossible for days at a time to bring scows alongside of the breakwater or to use floating plant of any kind owing to the roughness of the sea and the danger of breaking and sinking the plant when it came in contact with the sides of the work. It was very difficult to get cribs A, B, C, D, and E (Fig. 1) to maintain their position after the earth fill between these cribs and the old wharf was put in, as the cribs were placed on a rock bottom which sloped towards the outside and it was with the utmost difficulty that these cribs were held after this earth was put in. The sinking of the cribs was a hazardous undertaking from the contractors' standpoint, and came to a very fortunate conclusion, not one crib being lost in the construction.

Activated Sludge Tests and Experiments

THE University of Illinois have been conducting tests for some time on the activated sludge methods of treating sewage. The following article by Messrs. Bartow, Mohlman and Schnellback in Engineering News describes the design of the plant and its performance:—

The first series of activated-sludge experiments at the University of Illinois, begun November 1, 1914, was conducted in 3-gallon bottles. The second series was conducted in a tank 9 inches square and 4½ feet deep. The third series was conducted in four tanks each having an area of 10 square feet, and a depth of 9 feet. Experiments in the first three series were carried on by the fill-and-draw plan. At present, for the fourth series, a continuous-flow plant is being successfully operated. This series is conducted in the septic tank designed in 1897 for the city of Champaign. Early in 1916 this tank was placed at the disposal of the State Water Survey, and was reconstructed with the expectation that 200,000 gallons of domestic sewage be treated daily.

Design of Plant

The plant contains a screen chamber and pump pit, a grit chamber, an aeration chamber, a settling chamber, a blower room and a laboratory. A sludge-drying bed and a pond into which the effluent from the process may be discharged are also provided. Plans have been made for the installation of sludge-drying apparatus.

The sewage is drawn from the main outlet sewer of the city of Champaign. The daily flow is from 1,000,000 to 1,500,000 gallons. The manhole nearest the septic tank was modified to serve as a screen chamber and suction pit for the pumps. A weir was placed in the outlet to raise the sewage level and provide suction for the pumps. Vertical bars spaced with ¾-inch openings prevent coarse material from reaching the suction of the pumps. The sewage is pumped to a grit chamber by two centrifugal pumps, one with a capacity of 75 and the other of 110 gallons per minute. Each pump is belt-connected to a 3-horsepower electric motor. The grit chamber is 34 feet long, having two compartments each 1 foot wide. At the outlet is an adjustable weir through which the sewage must flow and where its rate can be measured.

The sewage flows from the grit chamber into the aeration chamber, a rectangular concrete tank 17 x 36½ feet in plan and 9½ feet deep, having a capacity, after allowances are made for the baffle walls and the sloping bottoms, of about 36,000 gallons. The chamber is divided longitudinally by three baffles into four compartments through which the sewage travels a distance of about 140 feet. The lower part of each compartment has sides sloping toward the centre, to a channel 10½ inches wide and 4 inches deep, extending lengthwise through the tank. Above this channel filtros plates are supported on T-bars that have been embedded in the concrete. The channel below the filtros plates was divided into sections for six filtros plates with the expectation that each set of plates would be separated from all the others and that the supply of the air to the plates could be regulated by an air pipe and valve for each set. Owing to the porosity of the sloping concrete sides it has been found impossible to regulate independently each set of plates. The aeration tank should be capable of treating 144,000 gallons of sewage and sludge per day if aerated during a period of 6 hours; 170,000 gallons if aerated 5 hours, 216,000 gallons if aerated 4 hours.

The treated sewage and sludge flow from the aeration chamber to the settling chamber. The settling chamber is 6 x 10½ feet in plan and 10½ feet deep at the lowest point. It has a capacity of 3,700 gallons. This would give a retention period of 24, 31 and 37 minutes with a flow of 4, 5 and 6 hours respectively, through the aeration chamber.

In order to assist the settling of the sludge, the liquid is passed down through the centre and up around the edges of a hollow wooden pyramid placed in the centre of the settling basin. The pyramid is 15 inches square at the top, 3 feet square at the bottom and extends to within 3½ feet of the bottom of the chamber.

From the settling tank the effluent flows over a weir to the creek or into the pond. The pond is formed by two dams placed across the abandoned bed of a small stream. It covers about 0.1 acre and is 3 feet deep in the deepest part.

The sludge is withdrawn from the settling chamber by an air lift and can be discharged into the raw sewage where it enters the aeration chamber, or can be diverted for experimental purposes, or to the sewer. Some sludge has been dried on a sand bed having an area of 256 square feet and a depth of 8 inches. The drying of sludge on the sand bed is not considered a success.

Air is supplied for aeration and for the air-lift by a rotary positive-pressure blower having a rated capacity of 300 cubic feet per minute, driven by a 15 h.p. electric motor. The air is filtered through cheese cloth spread over a wire box before it enters the blower suction pipe. The air is measured through a Venturi meter.

The plant has been in continuous operation for twelve weeks (on October 4, 1916) prior to which time it was operated intermittently for periods of from one to three weeks. No special effort was necessary to build up activated sludge. The plant has simply been put into operation, allowing the effluent from the settling chamber to escape while pumping back the sediment. From the start 90 per cent. of the suspended matter was removed and after 13 days of operation stable effluents were obtained.

The results achieved have been very gratifying. Purification is indicated by the presence of from 5 to 8 parts per 1,000,000 of dissolved oxygen and the stability to methylene blue of from 5 to 15 days. The effluent is odorless and generally clear, though at times, because of the insufficient capacity of the settling chamber, it contains small particles of sludge.

The plant has been run to obtain a clear effluent. Owing to the insufficient size of the settling chamber the actual rate of operation has been less than one-half of its rated capacity. Additional settling chambers are to be installed.

After satisfying ourselves that the plant could be run satisfactorily at a rate suitable to the capacity of the settling chamber, the rate has been increased to 150,000 gallons per day even though some sludge escapes with the effluent. At this increased rate, using 2 cubic feet of air per gallon of sewage, stable effluents have usually been obtained. Owing to the presence of sludge in the effluent, the effluent was allowed to settle in glass cylinders 30 minutes longer before taking samples for analysis.

Defects in a Concrete Sewer at St. Vital, Man.

Rapid Disintegration Due to Chemical Action—Caused by the Use of Limestone Aggregate and Porous Concrete—Impervious Lining Recommended

IN 1914, the rural municipality of St. Vital, Man., built a trunk sewer of reinforced concrete. In the fall of 1915, about a year after its completion, decomposition was noticed, and in February, 1916, Mr. M. T. Cantell, C.E., was called in by the council of the municipality to report on the defects which had been reported. The results of his examinations were incorporated in three interim reports which have been collected in a final report, recently made public. The following abstracts will serve to indicate the nature of defects which are liable to occur in sewers of this type and the means suggested for overcoming and offsetting them:—

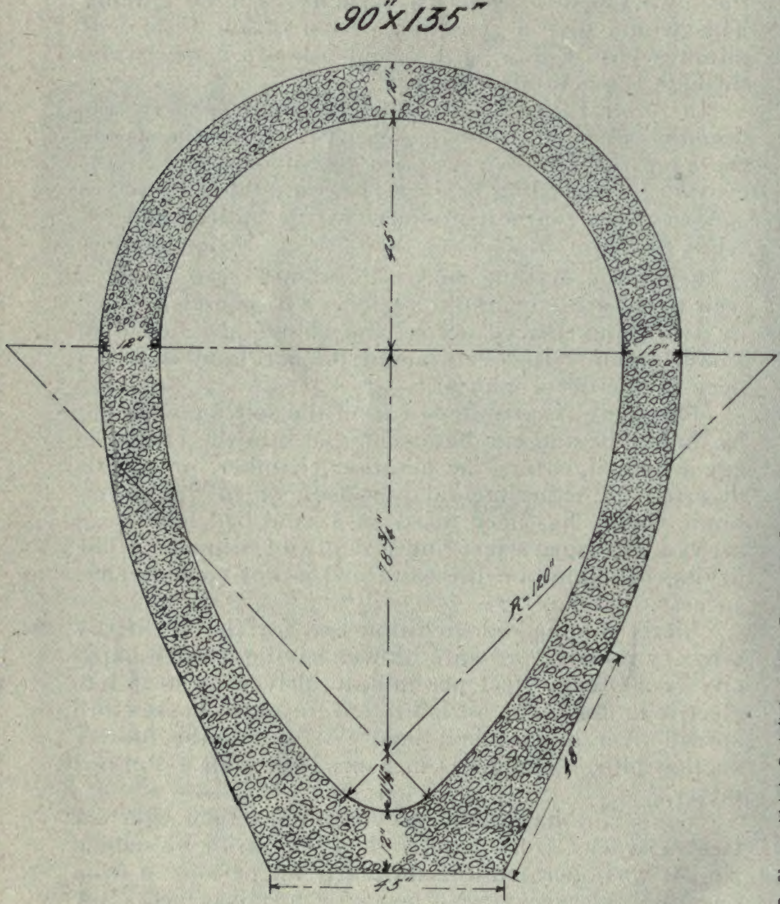


Fig. 1.—Typical section of trunk sewer of the rural municipality of St. Vital, Man.

In February, 1916, I made a careful inspection of the portion of the work between the Municipal Hall and Nichol Avenue, and found disintegration of the concrete is rapidly taking place, and to such an extent that if it is not immediately arrested destruction of the whole of this length of sewer is inevitable at an early date. I further examined a considerable length of the sewer north of Nichol Avenue, and found this portion also to be under the process of disintegration; although this is not so far advanced as in the more southerly portion, it will continue to disintegrate with the same ultimate result unless it receives early attention.

The sewer is egg shape in section and is constructed of concrete, as Fig. 1, the dimensions of this portion being 42 inches wide and 63 inches high, with the concrete six inches thick.

Upon careful examination I find the concrete composed of Portland cement and an aggregate consisting of siliceous sand and gravel, and broken limestone rock; the sand, gravel and limestone being in greatly varied proportions, in some batches the coarse aggregate consists almost entirely of broken limestone, in others gravel predominates. The proportion and quality of cement used throughout is satisfactory and appears to agree fairly closely with the 1 to 6 mixture and the other conditions called for in the specifications.

There is evidence of the concrete being mixed with an excess of water and of being deposited with insufficient or no tamping, resulting in a porous concrete of insufficient density to resist the penetration of moisture and deleterious gases.

The air in the sewer contains a large proportion of carbonic acid and ammonia, a small proportion of sulphureted hydrogen and a trace of marsh gas.

The soil in which the sewer is built consists of a plastic calcareous clay containing a small trace of alkaline matter, underlying about 18 inches of peaty vegetable earth in which there is a trace of carbonic acid, probably generated by decaying vegetation and carried in by surface water.

The disintegration is brought about primarily by a breakdown of the limestone aggregate of the concrete, through being attacked, chiefly by the carbonic acid and the ammonia, and to a smaller degree, by the other deleterious gases contained in the sewer air.

These chemicals have great affinity to carbonate of lime and carbonate of magnesia; the limestone consists almost entirely of the former, with, in some cases, a small percentage of the latter. The acids in the air are dissolved by moisture and thus rendered capable of attacking the carbonates and setting up chemical action which results in decomposition of the stone. The acids then attack the lime in the cement which

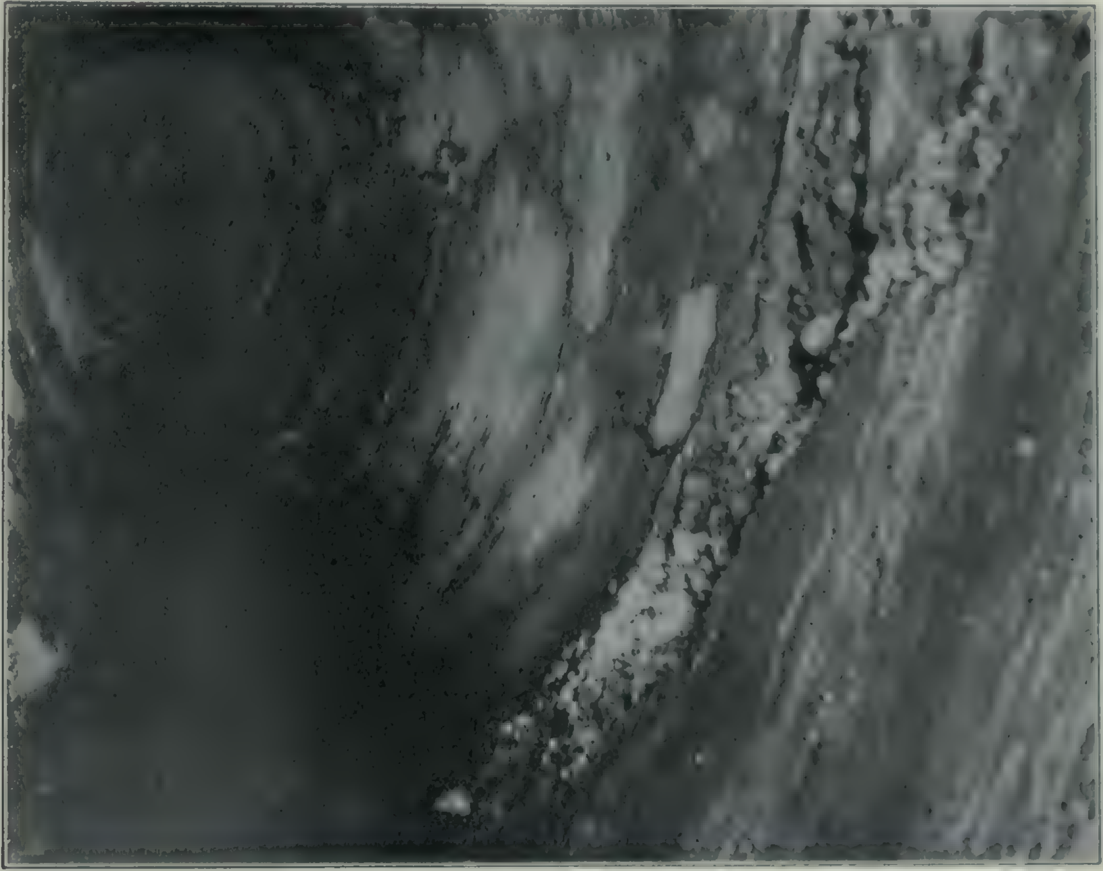


Fig. 2.—A section of the trunk sewer of St. Vital, showing dissolved lime and disintegration at sides and invert.

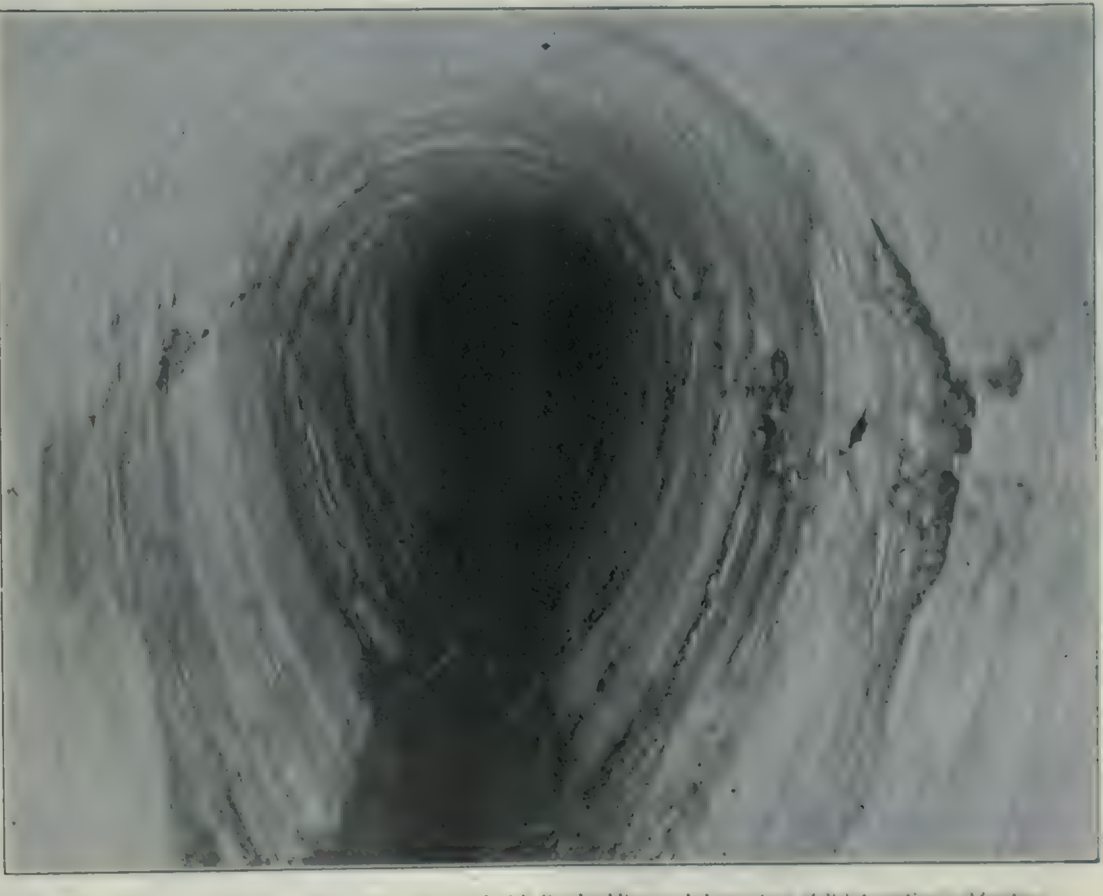


Fig. 3.—The surface in this case is completely covered with dissolved lime and shows signs of disintegration and fracture.

results in the complete disintegration of the concrete.

The chemical action and process of disintegration is observable in the following:

(1) The formation of sulphates and carbonates which are extensive and in various forms. Sulphate of magnesia is shown as a white salt-like efflorescense, and the sulphate and carbonates of lime as a creamy white substance running down the wall like a thick paint, and in numerous places hanging like icicles in the form of stalactites. These sulphates and carbonates exert an irresistible force during formation and when forming within the pores of the concrete they fracture, burst, or render friable, the surrounding material.

(2) By the gases attacking the limestone in parts more free from moisture and liberating the carbonic acid gas contained in the stone. This converts it into quicklime which hydrates in the presence of moisture, and in so doing it expands, fractures the concrete, powders and is subsequently converted into a paste of putty-like consistency, which is dissolved and washed away by water.

Cause of Defects

The whole trouble is therefore caused—

(1) By broken, soft granular non-crystalline limestone being used as aggregate.

(2) By the porosity of the concrete being such as to afford ready means for moisture from the exterior and interior of the sewer and for deleterious gases from the interior of the sewer to gain access to the concrete and to attack and break down the non-crystalline limestone and then the cement, and thus bring about complete disintegration of the whole mass.

The decomposing action is also favored by the sewer being very poorly ventilated; the gases do not readily escape, and are consequently more dense and penetrating than they would otherwise be.

Repair Suggestions

To restore the sewer to a satisfactory condition I recommend the following:—

(1) That about 400 feet between the Municipal Hall and Nicholl Avenue be entirely removed and reconstructed, for which it will be necessary to open up the trench to facilitate construction. A further portion of this length to have a part only removed and reconstructed; this can be done from inside the sewer and will not necessitate opening the trench above. The remainder of this portion to have small defective patches cut out and made good.

(2) That to preserve this portion from further disintegration and ultimate destruction, the whole of the inside, except the portion entirely reconstructed, be cleaned and lined with an impervious lining.

In the portion of the sewer which I inspected to the north of Nichol Avenue similar disintegration has commenced, but it is not at present sufficiently advanced to necessitate removal of any portion. To arrest disintegration and insure safety of the sewer I strongly recommend that this portion also be at once lined as described for the portion south of Nichol Avenue.

The exact length of the portion to be reconstructed cannot be determined until the trench is opened up as it is impossible to judge from within to what extent disintegration has spread on the outside. To entirely protect the concrete from further attack, it may also be necessary to treat a portion of the exterior to prevent the penetration of moisture, but this also cannot be determined until the trench is opened up at various points along the sewer.

In May, 1916, Mr. Cantell made a further examination of the entire sewer and found that disintegration in the part already referred to had greatly increased, a considerable length had entirely collapsed and large patches had fallen out in many places.

Other sections required repairing or replacing, while in others disintegration has but recently commenced and was not developing very rapidly, consequently repair was not so urgent.

On May 26th the engineer submitted a further report to the Council as follows:

I have excavated and exposed the exterior of the worst portion of the sewer and have made a further detailed examination of the nature and composition of the materials of which the concrete is composed and also the nature of the surrounding soil and the internal conditions of the sewer. As a result of this examination, I beg to supplement my previous report with the following:—

The coarse aggregate used for the concrete consists of from 60 to 65 per cent. of limestone in various degrees of crystallization, some of which is siliceous and of a metamorphic nature; about 20 per cent. consists of hard stone of igneous formation, chiefly granite and trap rock; the remaining 15 or 20 per cent. consists of soft granular limestone, i.e., limestone devoid of crystallization. The sand is similar in nature to the coarse aggregate but does not contain such a large percentage of non crystalline limestone. I cannot report differently on the cement; as far as can be ascertained from the finished product the specified quantity and quality was used.

Irregular Density of Concrete

The density of the concrete is very irregular. In places it is of average density but it is generally porous and in places exceptionally so, the cavities varying in size up to that of the stones. The soil contains a very small trace, practically a negligible quantity, of alkaline matter; it is insufficient to give rise to the formation of soluble salts likely to cause efflorescence and consequent disintegration.

The result of my examination fully supports my previous reports as to the cause of disintegration and decomposition of the concrete. The gases first act upon the soft non-crystalline and the feebly crystalline limestone and then upon the lime constituent of the cement with the result already described. The action of the gases is intensified by the presence of moisture due to percolation through the concrete from the soil and from the water within the sewer; this water dissolves the acids in the sewer air thus enabling them to easily attack the carbonate of lime and magnesia forming sulphates which are very soluble in water. Owing to porosity the concrete offers very little or no resistance to the penetration of the gases.

The disintegration invariably commences at the inside and varies in depth from superficial roughness to complete disintegration through the whole thickness of the concrete. At any one particular point it is greater at the inside than toward the outside, and is invariably greatest where the moisture most easily penetrates and the non-crystalline limestone is present.

Conclusions

My detailed examination fully indicates the following:

(1) That the disintegration is chiefly due to the use in the concrete of a large proportion of soft non-crystalline limestone, containing 90 to 96 per cent. carbonate of lime (lime, carbonic acid and water).

(2) That the disintegration would have been much less rapid and probably only superficial if the concrete

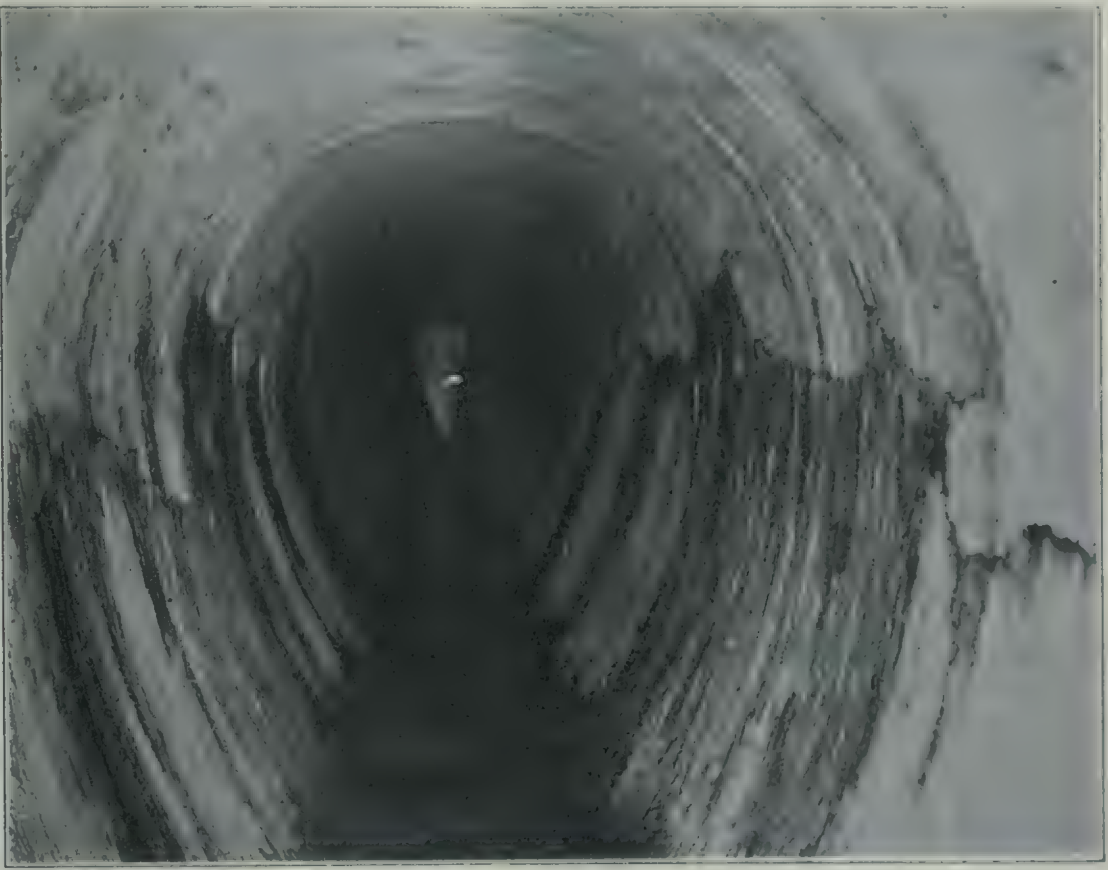


Fig. 4—This section shows cracks in side with the surface almost covered with dissolved lime.

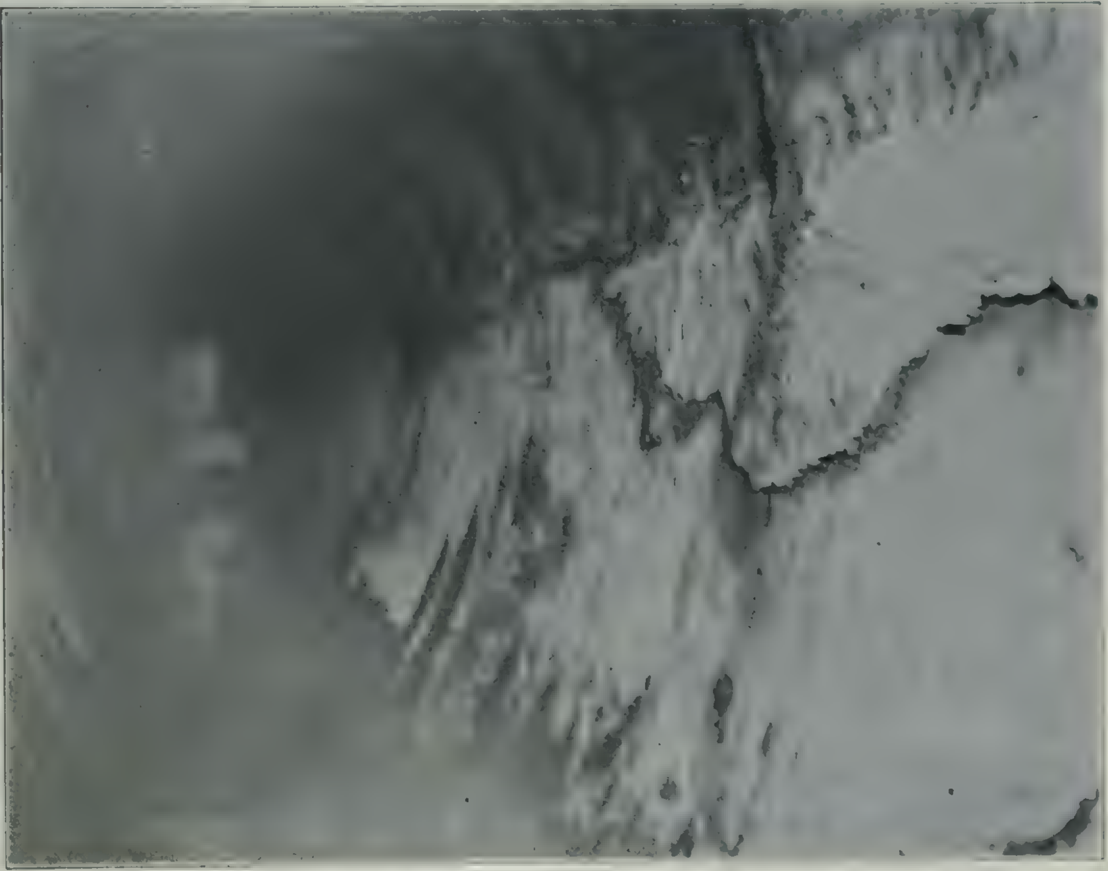


Fig. 5. A large fracture is observable along the side with a covering of dissolved lime on the surface

had been of sufficient density to resist the penetration of air and water, and had the sewer been better ventilated.

(3) That the disintegration would not have taken place if the interior of the sewer had been finished with an impervious lining. The existing lining consists of a coating of cement grout.

When an extension of the sewer is made I recommend the Municipality to refuse permission to use limestone of the class herein described as bringing about the disintegration, and to enforce means to secure a dense impervious concrete with a lining finished as described for the repair of the present sewer.

The accompanying photographs show the decomposition and disintegration in various stages. The white streaks and coating represent the sulphates and carbonates of lime which in places cover almost the entire surface. The dark streaks are the cement surface not yet covered with lime. The uneven broken patches observable in Figs. 2 and 3 are of putty-like consistency and can be easily removed without the use of tools. Figs. 3, 4 and 5 show fractures along the side.

Human Efficiency Methods Obliterate Individuality

A GREAT deal is said nowadays about efficiency. More particularly with regard to factory organization a lot has been done towards the elimination of waste effort and unnecessary motion with the object of speeding up production and increasing the value of the human element; in short, producing an efficient organization. Engineers like the late Dr. Taylor have spent a lifetime in devising systems of factory efficiency that appear to possess well-nigh perfect qualities in the application of human efforts. Other engineers, however, believe that the process of standardizing factory methods is dehumanizing and results in the transformation of the human element into mere machines. No scope is given, they say, for the exercise of ingenuity, no opportunity is given for workers to think for themselves or take an interest in their work. They become pure machines, their work pure drudgery.

This point of view is presented in rather a light vein in a recent address at the Engineers' Club, St. Louis, U.S.A., by Edward E. Wall, extracts from which are reproduced below:

I have a high regard for efficiency, provided I am allowed to define the word. If I were living in a community all of whose members were 100 per cent. efficient, I would move out as soon as possible, for two reasons—first, because I would not like to be kept keyed up to concert pitch all the time, even if it were possible; and, secondly, because it would be extremely disagreeable to live with people who never made mistakes. When you come to think of it there is an immense amount of enjoyment to be found in other people's mistakes.

Imagine yourself condemned to live among people who never wasted a second of time; never made a superfluous motion, never had an idle thought. All forms of pleasure would become work with a purpose. You would never have the satisfaction of complaining about any service. You could never complacently explain to your wife or your friends how much better a thing could be done if you had the matter in charge. You could not hold forth eloquently on the mismanagement of municipal departments, and tell how a million dollars a year could be saved. Everything would be so perfect and so well-ordered that there would be no pleasure in life, and you would welcome death as a relief, hoping to land in Hades where there was some variety.

"Efficiency" has become a most popular catchword during the last few years. You hear it on the street cars, you hear it in the restaurant and on the streets; and you read it in the papers and magazines. "Efficiency" as it seems to be understood now consists in training yourself to such an accurate measure of time and motion that you will have no opportunity to do anything but work.

From every platform, orators inflated with verbosity, hurl the word "efficiency" at you, and think they have said something. In nine cases out of ten the speaker has not even a bowing acquaintance with the real thing, and would not recognize it if he chanced to meet it. I have but little patience with the latest ideas of efficiency, as exploited in the exaggerated reports which are current, where the cure of all evils lies in the employment of an efficiency expert.

I can hardly believe that any business that has grown up and prospered under the same or successive managements, and where every detail has at some time been a subject of study by one or more men who are not altogether without brains, can be revolutionized in a few weeks' or months' review by a so-called expert.

Efficiency, as I would define it, is much the same as improvement or progress, a sort of perpetual reduction in the Probable Error.

Any man, following the same occupation or directing the same activities, year after year, who can make a better showing each year, may be called efficient. Or, if he can equal or better the results obtained by other men in similar lines of work, I should call him efficient. But to ask me to believe that efficiency consists in reducing human beings to the mathematical accuracy of automatic devices, so that they may be card-indexed, and each one placed in an organization so that he will fit in and become an infinitesimal part of some great machine directed by an expert, is too much of a strain on my credulity.

I want to live with people who are human, who occasionally waste time, who make mistakes, who are not by any means perfect, but who are just like myself, cheerful, morose, angry, friendly, sad or joyful by turns, just as circumstances determine.

Good Building Prospects in Montreal

Although the business of the Montreal building supply houses is not as brisk as it was, say, six weeks ago, it is by no means unsatisfactory considering the period of the year. The prospects for 1917 are fairly good; several important contracts have recently been let, including a Loew theatre, the construction of which is in the hands of the Atlas Construction Company; a very large munitions plant, to be built by Anglins, Limited; two picture theatres, and a chemical factory, while other contracts are pending—one for a ten-storey warehouse and another for the C. N. R. station. One of the largest contracts to be given out next year will be for the Princess Theatre, which is to be entirely rebuilt on a much more extensive scale; plans are also in progress for a hydro-aeroplane factory and several schools. Work promises to be good in the province; a commencement has been made on a boys' school at Lennoxville, and in the city of Quebec several building plans are either in the course of execution or are contemplated.

Bituminous Binders for Macadam Roads

Oil the best life saver—Methods of application and covering—Hot oil and cold oil processes—Cost data in specific cases

THERE is no type of improved rural highway more widespread than the macadam road of either the waterbound or bituminous classes. Such roadways may be built at a quite moderate expense, but the most potent objection seems to be the deteriorating influences which traffic has upon them. Unless strict vigilance and constant maintenance are applied, horse-drawn and motor traffic causes rapid wear and final destruction. This applies more particularly to the waterbound macadam where there is no adhesive binder to hold the surface together. In recent years frequent use has been made of bituminous oils for surface binders. These have been applied primarily to allay the dust, but now that the destructive influences of dust are recognized, the value of the oil surfacing in preserving the integrity of the surface is thoroughly appreciated. In Ontario and other provinces throughout Canada road improvements have been and will be extensively carried on, and the widespread use of macadam has suggested the problems of future maintenance. A regrettable feature of much of the work seems to be a lack of appreciation of the value of dust prevention and surface preservation. The use of bituminous oils forms an easily-applied and relatively inexpensive method of maintaining macadam roads, and in this connection the following adaptation of an article by T. M. Ripley in Engineering News, describing recommendations for oiling and best methods of procedure will be of interest:

Aside from the interest that highway engineers have in the use of bituminous oils on roads, every automobilist has a more or less personal interest, too. Probably no other portion of highway construction or maintenance has so many disrespectful things said about it. It dirties the car, and father and son lose their temper. It spots mother's new veil and sister's white hat, and they, also, become peevish.

Cold oiling to a madacam road is what the bath is to the small boy. He may not like it, but it is good for him; and no substitute has been found. The period of bad traveling over any particular piece of oiled road, should not exceed one week during the months of July and August, and frequently it is less.

Destruction of Macadam Roads.

Macadam roads are of two general classes—waterbound and bituminous-bound (penetration method). Both need constant maintenance, and a light application of bituminous oil, so far as shown, is the best "life saver."

Waterbound roads, subject to horse-drawn traffic of medium weight, have remained in fair condition for a number of years with little or no maintenance—so it is said. Under a traffic consisting of horse-drawn and motor-driven vehicles it is known that many waterbound roads rapidly go to pieces.

This can be readily accounted for, as the horse-drawn traffic loosens the top stone, the motor traffic raises the loosened binder, and the wind floats it into the adjacent fields. Further, a heavy, fast-moving motor vehicle not only displaces the loosened stones, but frequently throws them from the roadway.

Dust spells deterioration. The principal function of the first application of cold tar to a waterbound road is as a dust layer. The dust or binder remaining in place assures the stability of the top stone, and the road then wears out only by the actual grinding away of the road metal.

Application of Oil.

A cold-tar application on waterbound roads should be made annually until a thin bituminous mat has been formed upon that portion of the road taking the most of the wheel impact. Upon roads having an exceptionally dense and large proportion of pneumatic tired traffic this mat may extend over practically the entire width of the road after the first or second application, but on the large majority of roads it will be impossible to obtain this mat over the crown and along the edges until after at least two and probably three applications. This usual condition is due to the cutting of the mat by horseshoes and the lack of sufficient "ironing" by the softer tires to keep it bound together.

The bituminous roads do not, usually, need a cold oil treatment until after at least one year's use. But the mistake, frequently made in the past, was to wait too long before making the first application. This application should be made as soon as the stones are so much exposed that the road can be called toothy or chattery; ;and it must not be too chattery, for you will either wonder later where your cold oil application went to, or be forced into using a heavier asphalt or tar binder with correspondingly heavier cover, the limit of which is hot oiling.

Some years ago it was a statement of derision and contumely to say, "You are building these roads for the automobile owner," and arguments were strenuously advanced to combat that statement. To-day it is admitted that the roads are being built for the motorcar owner; for the automobile, truck, and motorcycle.

During the period of time when the road is undesirable because of the cold-oil application, the interests of the highway department, as the road maintenance force, and the interests of the automobilist clash. This clash is unavoidable unless more money is spent to achieve the same results; namely, more cover must be used in order to practically smother or entirely blot the bituminous application and thus prevent it from sticking to the car or being spattered on the occupants.

Details of Oiling Procedure.

The process of cold oiling is very simple, and consists of four main operations: (1) The patching of the road; (2) the sweeping of the road; (3) the furnishing and applying of the oil; (4) the furnishing and applying of the cover.

Patching should always be done by the departmental forces, unless some unusual conditions permit a cost-plus-percentage contract. No lump sum or unit price bid can be intelligently made or will be faithfully executed on this class of work.

The last three operations can be done under contract, although departmental forces, with the necessary equipment and one season's practice, can save the bulk of the contract profit, cover only what is needed, and so conduct the work as best to fit the road and traffic conditions.

Sweeping bituminous roads is frequently a joke and sometimes a calamity. This type of road is often as clean as wind and rain can make it, with the exception of a few inches on the edges. When sweeping is necessary, it is done usually with a horse-drawn machine, and it never should delay the work; moreover, the road must not be swept too far ahead of the oiling, as dirt from connecting roads, fields, etc., is constantly being brought upon the macadam. A few hand brooms should always be kept with the oiling gang, in order that horse droppings, material missed by the sweeper, etc., can be removed.

The cold oil is usually shipped to the nearest railroad siding in tank-cars, thence pumped into the oiler or supply tanks, and hauled to the site of the work. In some cases of long haul, small amount of oil, and inadequate equipment it is cheaper to purchase and deliver the material at the work, in barrels.

The value of the use of supply tanks for transporting the oil from the railroad to the work can only be determined for each individual case, as it depends upon the haul and the class of equipment. The use of supply tanks adds the cost of another pumping and the tying-up of more equipment, if anything goes wrong with the organization; nevertheless, with horse-drawn oilers or distributors the supply tanks are necessary for economy on hauls of more than three miles.

With this class of equipment the pumping of the oil is done by hand, using a heavy barreled boat pump and trough. With motor-distributor equipment upon which is mounted a power pump for transferring the material, much longer hauls can be made, and in the majority of cases the supply-tank equipment can be dispensed with.

The oil is delivered from the distributor to the road under pressure through nozzles set into a horizontal pipe at the rear of the distributor. The pressure is provided by a pump built into or set upon the frame of the distributor for that purpose. The amount of material spread is varied by regulating the pump, changing the nozzles, changing the speed of the machine (horses or motor), or by any combination of the three.

Lighter applications are used upon bituminous roads in good condition, and heavier applications upon new waterbound macadam or macadam in poor condition—poor condition comparatively.

Covering a Cold Oil Application.

Immediately after the application of the bituminous material it should have a covering, as thin as it is possible to spread and cover the oil. Depending upon the weather, the character of the road, the oil and the length of the work, one or more men must be continually "touching up" with more cover the places that "bleed through." Each new application of covering material should be made as thin as possible, in order that the amount used be a minimum, and that the road proper may absorb a maximum amount of the oil.

If clean, small stone are used for the first cover; sand, iron ore tailings, or even sandy loam in small quantities should be used as a second light-cover material. Small stone used without finer material is a perfect nuisance to automobile travel, being readily picked up by the tires, particularly if they are of the non-skid type. To bury the oil with clean stone so deep that traffic will not be unduly inconvenienced requires an excess of cover, and a large amount is eventually of no account as a wearing coat. The binder is too light (thin) to hold it in place.

The instructions should be: Put the cover on uniformly, as thin as possible, and often enough so that the road does not look greasy. Because an automobile traveling 25 or more miles per hour picks up some of the mat is no reason why more cover should be used, but it is a reason why the motor speeds should be reduced.

Hot Oiling Methods.

As carried on in this division, hot oiling is a process between cold oiling and resurfacing. The surfacing materials are greater in volume or size, or both, and the labor and machinery equipment more extensive than for cold oiling. Hot oiling is resorted to when the top course of the road is pitted or rutted, beyond repair by cold oiling, but when it is of sufficient thickness so that resurfacing is not required.

In general, the sequence of operations is as follows: Patching and shaping; cleaning; furnishing and making the first application of oil; furnishing, applying, and rolling the No. 2 stone (1-in. stone); furnishing, heating, and applying the second application of oil; furnishing, applying, and rolling the No. 1 stone (½-in. stone).

After the material is delivered along the road the equipment ordinarily required is: One horse-drawn sweeper; one-half dozen rattan or wire push brooms; two or more heating kettles (250 gallons); one distributor, with pump (same machine as used for cold oiling); one roller (8 to 10 ton); two or three hand pouring pots; shovels, picks, and other small tools.

From 0.4 to 0.6 gallons per square yard is applied, at a temperature of about 250 degrees F., to the old road, after it has been cleaned and patched. Patching also must include any small amount of reshaping necessary, for it is a doubtful proceeding to attempt to shape the road or remove any irregularities, except of minor degree, with the hot oil and its cover. The more regular or better shaped the road surface prior to the application the better the finished job.

Immediately after the first application of oil the 1-in. stone is spread so as to have, as nearly as possible, but one thickness of stone on the oil. The oil should be covered, but the stone should not be piled upon each other. The roller is passed over the newly-spread stone until the latter is crowded together, pushed down into the oil, and the surface has a generally smooth appearance. If the stone is brittle, or softer than desirable, care must be taken not to over-roll and thus preclude the penetration of the second pour.

The second, or squeegee, pour is then made (0.3 to 0.4 gallons per square yard) and the ½-in. stone spread upon it. The spreading of this cover or wearing course should be made as was the former, namely, thoroughly to cover the oil, but not pile up the material.

The rolling of the wearing course can proceed immediately if the weather is cool. On exceedingly warm summer days it may be necessary to keep the roller off this course for several hours. After the oil has hardened sufficiently, and the rolling can be done, it should be continued as long as other demands upon the roller will permit.

The Value of Hot Oiling.

The value of hot oiling and the advisability of doing it are considered debatable questions. Some roads treated in this manner two and three years ago are in fine shape; some are in miserable condition and the despair of the man in charge.

The kind and condition of the original surface, the amount of oil per application, the character of the stone used, and the ability of the men on the job all are factors of what may be called the first term. The factors of the second term are the kind of oil, the kind and amount of traffic, and the air temperature. Asphalts are more susceptible to temperature changes than tars.

If the application forms merely a blanket upon the old road with practically no bond, it will move under the traffic when such traffic is heavy enough or when the temperature is sufficient to soften the oil, or both.

In considering the two types of maintenance work as outlined in the foregoing it must be borne in mind that in general they are distinctive not only as to method of application, but also as to function. It must be further realized that one method can and is frequently shaded into the other. Such shading can be intelligently done only on a basis of experience.

In the costs, following, only the types as distinctive will be considered—namely, cold oiling with light cover and hot oiling with heavier cover. The shadings or gradations will be neglected. The cost figures below apply to road work in Division No. 3 of the State of New York, on which the writer is division engineer.

Cost Data on Hot and Cold Oil Applications.

Labor is, in general, the same over the entire State of New York. The prices of asphalts and tars vary only as to freight rate; the price of stone and fine cover as to availability of supply—namely, from digging it out of a bank along the road to purchasing from commercial organizations and payment of freight and haulage.

Light covering material can be obtained upon only about 5 per cent. of the total mileage. Therefore, local material can be disregarded in a general cost statement. There are two commercial stone quarries in the divisional area of 7,700 square miles. Only one of these furnishes material that can be used by this department, and that one is on a branch railroad.

During the season of 1915, in Division 3, there was cold oiled 240.45 miles of macadam road, equal to 1,961,102 square yards of metaled surface. The amount was divided as follows:

Treated With Tar.

	By contract.			By departmental forces		
	Amount.		Cost per	Amount.		Cost per
Type.	Miles.	Sq. yd.	Sq. yd.	Miles.	Sq. yd.	Sq. yd.
Waterbound.	29.75	258,498	$0.04907	68.52	528,510	$0.04268
Bituminous..	18.18	157,643	.04824	32.16	270,995	.03754
Treated With Asphalt.						
Waterbound.	8.62	60,660	.03756	5.82	29,936	.03716
Bituminous..	75.55	647,390	.03857	0.80	7,470	.05055

The cost of tar (cold application) f.o.b. destination was 7c per gallon in tank-cars. The cost of asphalt f.o.b. destination was 3.8c per gallon in tank-cars. No local material was used for cover. The costs for contract work are the actual final estimates, and do not include the departmental inspection. The costs for work by departmental forces are the actual payroll vouchers (including inspection), and do not include machinery depreciation.

The following costs by departmental forces are taken from Jefferson County work, under Arthur G. Bruce, county assistant, for the reason that 85.53 miles, equal to 704,504 square yards, was done in that county. The remaining work was in widely scattered parts of the division, where most of the work was done under contract, and where the equipment was more nearly incomplete. In Jefferson County two Packard motor trucks, one three and one five-ton, were used for hauling materials and transporting men and equipment, thereby facilitating the work. The lighter truck was the more efficient. Neither cost, as shown, includes the division engineer or Albany office charges.

A typical cost analysis of a contract job (cold application of high carbon tar) is as follows:

Length of road—miles treated	14.7[illegible]
Width of road—feet treated	16.0
Area of surface—square yards treated	[illegible]
Average haul of material—miles	6.0
Bituminous material—gallons per square yard	0.25
Cover—pounds per square yard	14.0
Cost of sweeping and furnishing and applying oil and cover per square yard	$0.04816

A typical cost analysis of a departmental labor job (cold application of high carbon tar) is as follows:

Length of road—miles treated	[illegible]
Width of road—feet treated	14.0
Area of surface—square yard treated	26,940.0
Average haul of material—miles	6.0
Bituminous material—gallons per square yard	0.25
Cover—pounds per square yard	14.0
Cost of sweeping and furnishing and applying oil and cover per square yard	$0.04005

The cost of hot oiling in 1915, based on the only job done (by departmental forces), was as follows:

Type.	Miles.	Sq. yd.	Cost per sq. yd.
Bituminous macadam	1.6	11,260	$0.2387

In 1914, 14.57 miles were hot oiled by two different gangs (departmental labor), as follows:

Type.	Miles.	Sq. yd.	Cost per sq. yd.
Waterbound	14.57	102,572.8	$0.2002

A detailed statement of the 1915 hot oil job is:

Cost of 1-in. stone delivered on shoulders of road, at $2.50 per cubic yard	$865.00
Cost of ½-in. stone delivered on shoulders of road, at $2.50 per cubic yard	
Cost of high carbon tar binder f.o.b. destination, at at $0.1075 per gallon	971.88
Cost of unloading and hauling high carbon tar binder—4½ miles—at $0.0087 per gallon	78.50
Cost of patching road, heating, and applying tar and applying cover, at $355.89 per mile	369.56
Cost of rolling (rollerman and fuel)	112.00
Depreciation on machinery (20 per cent. of purchase price)	93.00
Total cost	$2,687.94
Number of square yards covered	11,260
Cost per square yard	$0.2387

Officers of Regina Branch C. S. C. E.

The following officers for the Regina Branch of the Canadian Society of Civil Engineers were elected at their annual meeting:—Chairman, L. A. Thornton; vice-chairman, W. R. Harris; members of executive, R. J. Lecky, E. G. W. Montgomery; secretary-treasurer, J. N. deStein.

The following is a short program of papers to be dealt with by members of this branch during the ensuing year:

Notes on Town Planning, by L. A. Thornton.

Some Aspects of Indian Engineering, by E. G. W. Montgomery.

Drainage Problems in Saskatchewan, by C. S. Cameron, D.L.S.

Specific Treatment of Concrete in Our Climate, by W. R. Harris.

Need of Engineering Supervision in Location, Construction and Maintenance of Public Highways in Saskatchewan, by H. Ross McKenzie and F. W. Murray.

From Conception to Completion—the Western Railroad, by J. N. deStein.

The Fire, Water, and Light Committee of Nelson, B.C., have recommended to the City Council the installation of a third unit at the local power plant, to cope with increasing demand and to anticipate any possible breakdown of the present plant.

Scientific Research in Relation to the Industries

In view of the recent appointment of a Commission on Industrial Research and the increasing interest being shown by Canadian manufacturers in the applications of the principle of science to industrial processes, the following abstract of a paper by Dr. Chas. P. Steinmetz, chief consulting engineer, General Electric Company, before the Franklin Institute, will prove of interest. The author differentiates between scientific research as carried out by educational institutions and by the industries, and seeks to limit the nature of the respective experimental investigations in accordance with the difference in available facilities. He points out that there is a divergence in the methods of recording the results of investigations, educational researches being published in the so-called scientific publications, while industrial researches are recorded through the medium of the engineering papers, and a failure to give proper recognition to the latter has resulted in an incomplete record of scientific progress. Only by a proper appreciation of the value of the trade publications can the records of science be made complete and thereby valuable. The paper is abstracted below:—

Industry Depends on Engineering.

Industry, and with it all our modern civilization, depends on engineering. Engineering, however, is nothing but applied science, and science thus is the foundation, scientific research the ultimate means which have created our civilization. Through ages, the chief homes of scientific research have been the universities and other educational institutions. During the last generation, however, the industrial development has been so rapid, and the demand for the results of scientific research so great and urgent, that the universities have not been able to supply it, and the industries, especially the more powerfully organized modern industries, as electrical engineering, chemistry, etc., had to enter the field of scientific research. The country's educational institutions did not advance in fostering scientific research to the same degree as the industries advanced, and many universities and educational institutions rather retrograded in scientific research, became submerged in a false commercialism which figured the output of the college in student hours per professor, judged efficiency by the percentage of students graduated, and altogether too often wasted the university's best assets, its professors. Thus we find in our colleges men who had shown themselves capable as investigators to do scientific research work of the highest order, overloaded with educational or administrative routine, and deprived of the time for research work. Private industries rarely commit such crimes of wasting men on work inferior to that which they can do; industrial efficiency forbids it.

Thus, when with the advance of industry a more rapid extension of our scientific knowledge was demanded, than given by the educational research institutions, research laboratories were established in the industries. Some of them very soon showed their ability of producing scientific work of high character.

However, these scientific research laboratories of the industry represent only a part, often the minor part of the research work done within the industry, and in many places throughout the industrial organization opportunity is afforded for the right men to carry out scientific research. Thus in the material testing laboratories, their apparatus testing departments, development sections and laboratories, etc., research work is being carried out, and as a rule is encouraged by the corporations.

When speaking of industrial research laboratories, we must not forget the private testing laboratories, development laboratories, etc., which have been established and which to the smaller industrial organizations take the same position, and do the same work, as their own laboratories to the great industrial corporations.

Theoretically, there is a limitation imposed on scientific research work in industrial establishments: It should be of such character, that it may lead to results which are industrially useful. In reality, however, this is no limitation at all, but there is no scientific investigation, however remote from industrial requirements, which might not possibly lead to industrially useful developments; and obviously no immediate or direct usefulness is expected; any investigation offering a definite prospect of industrial utility, is not scientific research, but is industrial development or design. Experience indeed has shown that it is rare that sooner or later some industrially valuable results do not follow, no matter how abstruse and remote from apparent utility a scientific investigation may appear, and any scientific research whatsoever thus is industrially justified.

Some research work can be carried out more efficiently by educational institutions, others by the industry. In general, for industrial research, better facilities in materials and in power are available, but high class skilled labor, of investigators and research men, such as available in university research by the graduate students, is expensive in the industry. Thus researches requiring little in facilities, but a large amount of time and attention of research men, are especially adapted to educational laboratories, while investigations requiring large amounts of material or of power rather than time of the investigators, are specifically adapted to the industry, and often beyond the facilities of the educational institution. Efficiency thus should require a division of research between educational and industrial laboratories in accordance with their facilities, and where this is done, the results are splendid.

Limitation of Research Work.

Unfortunately, this limitation of research work in accordance with the available facilities is not always realized, and especially educational institutions not infrequently attempt research work, for which industrial laboratories are far better fitted, while research work for which the educational institution is well fitted, which the industry needs but cannot economically undertake, is left undone. It is usually the desire to "do something of industrial value" which leads universities to undertake investigations on railroading and similar subjects, in which the probability of adding something material to our knowledge is extremely remote, or to undertake investigations on industrial iron alloys in competition with the vastly greater and more efficient research of industrial laboratories.

In industrial research, the liability exists of limiting the work into such a narrow field, that it has little general scientific value. In educational research inversely there is sometimes the tendency to generalize beyond the limits justified, and so draw wrong conclusions.

As regards the quality of the scientific research work carried on in industrial organizations compared with that in educational establishments, there is no material difference, but the work done in the industry, just as that done in universities, varies from scientific research of the highest quality, down to investigations which are of little, if any value, investigations crude and inaccurate or directly erroneous in premises, in method and in results and their interpretation, or investigations, which while correctly conceived and correctly made, are useless, because essential conditions have not been controlled or recorded. Still worse are those pseudo scientific investigations occasionally met, which own their conception to the desire of self-advertisement or are made for economical or legal purposes, such as, for instance, to give the appearance of a scientific standing to some theory which some inventor had recorded in his patents. Such work—met occasionally, though less and less frequently—in industrial as well as in educational institutions, is the one which tends to discredit scientific research in the eyes of the layman, who cannot discriminate between science and pseudo science.

The Place of the Trade Publication.

The essential difference between industrial and educational research, however, is met in their method of publication: the publication mediums of scientific research carried on in educational institutions are the scientific publications published more or less under the direction or supervision of universities, while the publication mediums of the scientific research carried on in the industry are the technical or engineering papers, and only occasionally an abstract reaches the scientific publications. Unfortunately a large number of the scientists still look on publications in the technical press as unscientific, take no cognizance of it, do not recognize it in scientific abstracts, reviews, etc., and as the result, a large and steadily increasing part of the scientific research of the country is practically lost to the scientists, is not available or easily accessible, by not being recorded, abstracted or indexed in the records of scientific progress.

Amongst the worst offenders in this unjustified exclusiveness are the physicists, while the chemists make a recommendable exception: In the "chemical abstracts" published by the American Chemical Society, the results of industrial research as well as those of the chemical university laboratories are recognized, and these abstracts are therefore comprehensive and valuable, which cannot be said of the abstracts of some other sciences. Possibly the reason is, because applied chemistry is chemistry just as well as theoretical chemistry, while applied physics goes under the name of engineering, and the average theoretical physicist is rather inclined not to recognize engineering as scientific. Some excuse hereof may be found in the nature of the two classes of publications, the physical science publications and the engineering publications. The former accept for publication only scientific papers, exert a critical judgment, and the appearance in the scientific publication medium thus implies that the article, at least in the opinion of the editors, is of scientific value. This is not the case, and cannot be the case with the engineering or technical publications; the technical press is the medium of all the publications of those engaged in the industry, from scientific research of the highest value, to mere commercial statements, and the appearance of an article in an engineering paper or transaction does not imply, nor intend to imply, that it is of scientific value, but the discrimination between scientific worth or otherwise, which in the scientific publication is attempted by the editors, has in the engineering press to be left to the reader or abstractor. If, however, the purpose of the engineering publication is to bring all classes of industrial records, and it thus includes commercial and other articles, this is no justification to refuse recognition to scientific papers contained in the same publication, but rather makes it desirable, and indeed necessary in the interest of our nation's scientific efficiency, to find some means of organization to carry out this discrimination and make available to the scientific world at large, the scientific work contained in the annals of applied science, that is, engineering.

To conclude, then: scientific research of the highest class is carried out to-day in our nation in educational institutions as well as in industrial organizations and private testing laboratories, and the scientific research work in the latter is increasing at a far greater rate than that in the former. The publication mediums of scientific research of industrial organizations are the engineering publications and transactions, and the failure, in many branches of science, of recognizing the engineering publications in the records of science, thus makes the records of science incomplete, and increasingly so, therefore seriously retards the progress of science, and with it that of applied science, that is, engineering, and as engineering is the foundation of our civilization, it constitutes a serious menace to our nation's progress.

It is therefore important that those scientists who are engaged in keeping the records of science and making the results of scientific research available and easily accessible, should recognize all sources and records of scientific research, including those of applied science, that is, the engineering publications, and should undertake the work of reviewing the technical press as well as the purely scientific publications, judging and selecting from the former those publications which are of scientific value, and recognize them. Only then will our records of science be complete and thereby valuable.

Minerals of New Brunswick

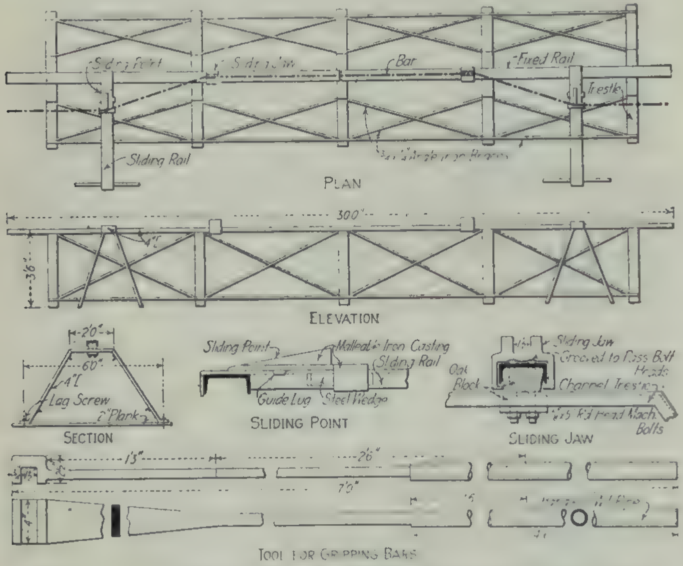
The minerals of New Brunswick, developed and undeveloped, cover a considerable range. They include an antimony deposit at Lake George, which has recently been taken over by the Northern Antimony Smelting Company with a capitalization of $2,000,000; bituminous coal deposits (estimated to contain fifteen million tons); iron, gypsum, oil shales, manganese, graphite, tungsten, molybdenite, copper, lead, zinc, galena, barytes, infusorial earth, black, grey and red granites, freestone, sandstones and other minerals, which offer a very attractive field for investment. A discovery of a rich bed of galena ore was recently made at Maple Grove, York County, by W. H. Griffin, a provincial game guide. Two veins of 22 feet and 12 feet respectively have been uncovered. Ontario parties have secured an option of the mine

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

A Device for Bending Both Ends of Reinforcing Bars at the Same Time

A rigid, durable steel bench which can be quickly set to make any sort of bends in reinforcing bars up to 1½ inches square, and on which both ends of a bar may be bent at the same time, is described by G. W. Davidson in Engineering Record. It was recently built by the writer while steel foreman on a reinforced-concrete contract, and has given satisfactory service on two consecutive jobs of this sort.



Details of a handy bending-machine for double-bending the two ends of a bar at the same time.

The main part of the machine is a 30-foot fixed rail made of two 15-foot lengths of 4-inch channel mounted on five angle-iron trestles. At right angles to this rail, and built, as shown in the details, so that they can be moved along it, are two sliding rails supported at their outer ends by angle legs. These also are made of channels. Between the two sliding rails on the fixed rails are mounted two movable jaws. On each of the movable rails is mounted a sliding point, which is used to gauge the first bend and against which the second bend is made. A scale is marked on each of the three rails, so that the jaws, movable rails and points can be quickly set without the use of a rule to make a double bend ranging in offset from 3 inches to 4 feet. The bending tools shown in this sketch are used to afford sufficient leverage to make a sharp bend quickly. Plate washers are used in the jaws when bars of less than the maximum size are bent.

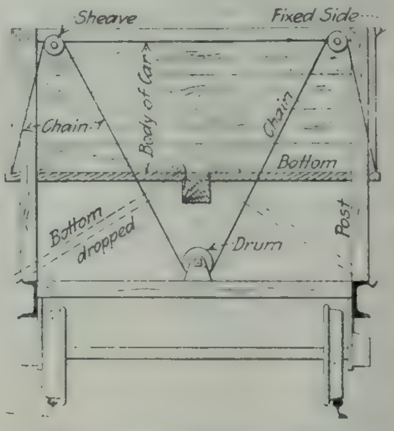
In using the machine a bar is laid in the two movable jaws. One man with a bending tool standing outside the bend grips the rod and bends it over past the movable point and a second man with another tool catches the rod beyond the movable point and bends it back against it. A large output can be obtained with the machine by using four men, bending both ends of the bar at once, and having extra laborers to supply and take away the bars.

The machine is rigid, durable and large enough for bending any steel ordinarily required. On the other hand, it is readily knocked down for shipment, and two men can erect it in an hour. Five men can move it around the job. With this machine two men can bend 1¼-inch square bars steadily without fatigue.

An Improvised Dump Car

To handle the material from the foundation wells of caissons of the new Fox River bridge of the Chicago, Burlington & Quincy Railroad at Aurora, Ill., a special dump-car was rigged up on the work, which is described in the December issue of Engineering News. As shown, it runs on a standard-gauge track on a temporary filling trestle, and in loading position it stands under a hopper. The excavated material is hoisted in small buckets and emptied into skips; when these are full, they are raised and swung over the loading hopper by a derrick.

The car body is 6½ x 5 feet and 30 inches deep, with a capacity of about 3 cubic yards. It is mounted on a frame of steel channels, with two axles and 18-inch wheels. The floor is set high and consists of two sections or leaves hinged along the centre line and held up by chains attached to the outer side and wound upon a drum. To dump, the drum is released, and the floor sections fall to an inclined position, allowing the contents to slide off on both sides. The drum is then operated with a ratchet bar to wind up the cables and raise the floor sections to a horizontal position.



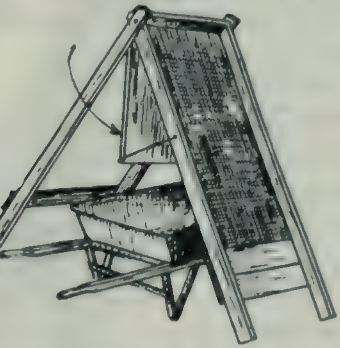
An improvised drop-bottom dump-car

In operation the car forms part of an endless hauling system. A cable attached to one end is led direct to the drum of a hoisting engine; another cable leads from this engine to a snatchblock on a deadman at the end of the trestle, and back to the car. When full, the car is hauled out on the trestle, being ridden by a man who trips and closes the floor.

A Handy Sand Screen Attachment

A handy attachment for a sand screen is illustrated. Anyone who has occasion to screen material into a wheelbarrow or box will appreciate its advantages.

It can be made in a few minutes of light lumber, sheet metal, or even canvas with a strip of wood tacked to the lower edge.—Concrete.



A screening attachment to direct materials into a wheelbarrow.

Time Required for Mixing Concrete

The chief engineer of the Pennsylvania State Highway Department reports that his practice is to mix every batch of concrete for a period of 1½ minutes, the reason for this being that a number of experiments made by him indicated that the maximum strength commensurate with economy in cost of mixing was obtained from mixtures of this timing.

The following are the results given by the experiments in question, all the results being based on tests at the age of eight days.

Time of Mixing Minutes	No. of Revolutions	Compressive Strength of Concrete lb. per sq. in.
½	9	1400
1	17	1587
1½	26	1926
2	36	1661
3	51	1673

Opinions as to the most advantageous period that should be allowed for machine mixing are apt to differ. The point, however, is one that could readily be settled by a series of simple tests.

Manure Protects Concrete in Cold Weather

Experiments have been conducted at the Lewis Institute in Chicago to determine the effectiveness of manure as a protective covering for freshly-laid concrete to prevent disastrous results in cold weather. In these tests slabs of concrete exposed to outdoor conditions were covered with 2, 4 and 6 inches of fresh manure obtained from a livery stable. The results proved that the 4 and 6 inch layers had high protective qualities and were sufficient to afford the concrete a protection against a drop of 25 or 26 degrees in temperature. The 4-inch layer seemed to be as effective as the 6-inch, and appeared to be an ample protective covering against a temperature of 12 degs. F. The manure should not be allowed to come in direct contact with the freshly-laid concrete, but should be kept clear by the insertion of building paper, or even newspaper between the concrete and covering.

Twenty-two farmers in the Townships of Windham and Townsend, near Simcoe, Ont., have decided to petition for an extension of hydro-electric power for their farms.

The First Unit of a Fine School at Lennoxville, P.Q.

John Quinlan and Company, Montreal, are now at work on the first unit of the Lennoxville School—a preparatory school which will form one of several buildings. The proposed buildings will be financed by Mr. J. K. L. Ross, of Montreal, and will constitute a preparatory college for the universities, and will, when completed, form an educational centre among the best on the continent. The buildings, now being designed by Mr. K. G. Rea, F.R.I.B.A., are in the Tudor style and follow the lines of the great English public schools, being grouped around quadrangles and connected by cloisters. The building being erected occupies an area of 220 feet by 60 feet, and affords school and living accommodation for sixty boys. It is divided into two houses, each with its own entrance. The housemaster's residence adjoins the school and communicates on all floors with the school building. There are three storeys and a basement, the construction throughout being entirely fireproof and of the highest class. The foundations are of concrete, while the superstructure will consist of a steel frame with reinforced concrete floors. The base is of granite and the walls above are brick with stone facings.

The basement floor is devoted to play rooms, music rooms, lavatories and shower baths. The large play room is lined with facing brick. The first floor contains a large central hall and main entrance panelled in oak with heavy oak beamed ceiling. Corridors run the entire length of the building, giving access to six class rooms, which have an oak dado and plaster walls above. On this floor also there are reading and writing rooms, master's common room, etc. The second and third floors are devoted to living and sleeping quarters. The second floor has four dormitories, each with its own bath room. Separating the dormitories is accommodation for two floor masters, consisting of bedroom, sitting room, and bathroom—so planned that proper supervision of the boys is easily obtainable. The dormitories and corridors have an oak dado with plaster walls above. The third floor has two dormitories and floormasters' accommodation, planned exactly as on the second floor. On this floor also there are two large sick-rooms with nurses' quarters, all finished in modern hospital construction. This portion is so planned that it can be isolated from the rest of the building. The matron's quarters are on this floor, consisting of bedroom, sitting room and bathroom, and adjoining are the sewing and linen and maids' rooms.

A freight elevator runs from the trunk storage room in the basement with access to every floor. The staircases throughout are of metal with marble treads. All corridor floors are of linoleum, while that of the central hall is of marble.

Lumber by the Mile

The following letter received by a lumber company in the West and published in the Chicago Tribune, is likely to draw a smile to the reader:

Dear Gentlemen: In your letter to me quoting prices on lumber, let me know what you mean by M. feet of lumber. Does that mean one mile of lumber? And do you lay it out and measure how much is in a mile of lumber? You know the place I want to build should not reach a mile, but should be only a little house for chickens. Be sure to let me know right away how much is it an mile of lumber. Yours very respectable.

TIM ———, Ottumwa, Ia

Annual Meeting of Victoria Branch C.S.C.E.

The annual meeting of the Victoria Branch of the Canadian Society of Civil Engineers was held on the 13th inst., with an attendance of 21 members. The following officers were elected for the ensuing year:—

Executive Committee—Chairman, D. O. Lewis; vice-chairman, R. A. Bainbridge; treasurer, E. Davis; secretary, R. W. Macintyre; C. Hoard and E. G. Marriott; ex-officio (past chairmen), F. C. Gamble and H. W. E. Canavan; auditors, Lewis W. Toms and J. B. Shaw.

On the 9th inst. the Provincial Division for B. C. met in Victoria at the Branch rooms, for the annual meeting, and the proposal that those now in office should be re-elected for 1917 was unanimously carried. The chief business dealt with was the completion of by-laws for the Division and the submission of same to both branches and headquarters for approval and adoption; the Secretary, Mr. Cleveland, promised to have copies ready at an early date. The officers of the Division are:

Chairman, T. H. White; secretary-treasurer, E. A. Cleveland. Representatives of Branches—Vancouver, R. F. Hayward and A. D. Creer; Victoria, D. R. Harris and W. Young. Representing outside members of British Columbia, W. K. Gwyer and A. E. Ashcroft.

Tool Concern Opens Toronto Office

The John Bertram & Sons Company, Limited, and their associated company, the Pratt & Whitney Company of Canada, Limited, announce that they have opened a Toronto office at 1002 C. P. R. Building, Toronto, for the convenience of their many customers in Toronto city and district. An efficient sales' staff has been appointed and will be maintained at Toronto; also a large and well assorted stock of P. & W. goods will be carried in Toronto, to insure prompt deliveries.

Work is to be proceeded with at once on the construction of a new transformer station for the Welland Hydro-Electric Power Commission, Welland, Ont., with a capacity of approximately 5,000 h.p. at the beginning, with provision for an additional 5,000 h.p. when necessary.

Mainly Constructional

East and West—From Coast to Coast

The building permits issued in Paris, Ont., during the year are valued at $10,985.

The city of Verdun has received legislative authority to borrow $500,000 for public works, half of which will be for a system of underground conduits.

During the past two years in the city of Toronto there have been building permits issued by the city architect to the value of $16,000,000, and 50 per cent. of these have been for fireproof structures.

Net profits of the Dominion Bridge Company, Limited, in the year ended October 31 last, were $2,776,390, more than doubling the record of the previous year, and more than four times the figures of 1914. Profits as shown were after deductions for depreciation on plant, machinery, etc., these including, according to the directors' report, the full cost of extensive additions to plant and equipment erected or installed for the execution of war orders. Profits were equal to 42.7 per cent. on the capital stock, against 20.7 per cent. a year ago and 9.7 per cent. in 1914.

The Quebec Government will build a main highway from Levis to St. Lambert, on the south shore of the St. Lawrence. The Government have also decided to charge three per cent. on money borrowed by the municipalities under the Good Roads Act for a period of 41 years. This is an increase of one per cent., but the Government may, if the state of the money market permits, authorize the old rate on any amounts previously requested but not received. The Government propose to borrow next year an additional five million dollars, under the Good Roads Act, making a total of twenty millions.

Contractors on the Greater Winnipeg Water District aqueduct will next spring be permitted to obtain men for the work from any source available. The work during the past summer was hindered to quite an appreciable extent by the shortage of labor, but under the terms of the contract, the contractors must employ labor from the confines of the district. A motion has, however, been passed by the Board, removing the restriction regarding labor, owing to the urgency of having every portion of the work completed within the time limit; but it is stipulated that interned aliens must not be employed and that British subjects must receive first preference.

for tenders on the group plan, each group being for a different trade. All tenders are on the amended specifications which have been prepared by the architects and engineers. Division "A" will consist of tenders for the masonry and concrete work. This is the important group and includes the actual construction of the walls, etc., of the edifice. The successful tenderer for "A" will be made the general contractor. If he be the successful tenderer for any of the other divisions he will carry out that work at the price of his tender. If some other contractors get the other groups they will be placed in the position of sub-contractors to the contractor for "A," who will supervise and be responsible for the discharge of the sub-contracts on a 5 per cent. basis.

Personal

Mr. Taylor, of the Pilkington glassworks, recently delivered an interesting address before the Engineers' Club, of Thorold, Ont., his subject being, "The glass industry."

Mr. W. F. Angus, vice-president and managing director of Canadian Steel Foundries, will shortly retire from these positions to take executive office with the Dominion Bridge Company. Mr. Angus was with the Dominion Bridge Company as engineer and draughtsman in 1896, and also served for a time with the Laurie Engine Company. He afterwards joined the Canada Switch & Spring Company, which became the Montreal Steel Works, where he remained until 1911, when, on the formation of the Canadian Steel Foundries, he was appointed vice-president and managing director, a position which he has held since that time.

Obituary

Captain John Trethewey, a retired mining engineer, died on Christmas day at the age of 77, as a result of heart trouble. Capt. Trethewey was a well-known authority on matters pertaining to his profession. He was identified with a number of mining enterprises, and for years was associated with the Silver Islet Mines in the Lake Superior district, as well as the Port Arthur mines. He was born in England, and after coming to Canada, first settled in Sherbrooke, Que. For twenty years he was a resident of Owen Sound, and ten years ago retired and came to Toronto to live.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **January 10, 1917** **No. 2**

Principal Contents

Page
Editorial ... 19
Municipal Waste Disposal Plants ... 21
Bituminous Mortars for Pavement Fillers ... 23
Hospital for the Insane, Whitby ... 25
Practical Hints for the Contractor ... 45
Mainly Constructional ... 46

Construction Methods at Government Institution

THE Provincial Government Hospital for the Insane at Whitby, of which a descriptive article covering the main construction features occupies a prominent place in this issue, offers striking evidence of the radical program of social reform which the Ontario Government has been promulgating. As previously demonstrated in such institutions as the Provincial Reformatory at Guelph, this government has been consistently adhering to a policy of providing the most helpful care for those who, through misdemeanor or force of circumstances, are made dependent on public care, and this latest effort is but a continuance of the same advanced thought. The new Whitby Hospital aims ultimately to provide for the requirements of the mentally afflicted on a plan, more adequately worked out, it is believed, than ever heretofore. It is a matter of no little pride that the citizens of Ontario will be able to claim an institution conceded to be unexcelled anywhere in the world and which in its arrangement and equipment will comprise the most distinctive improvements that have been revealed by a careful study of existing hospitals and the results of an extensive series of original researches and experiments.

Great credit is due to the Provincial Secretary's Department, under the direction of which the project was carried out, for its foresight and wisdom in apprehending the problems which insanity treatment in Ontario involves, and credit is no less due to the architects and builders for the care which has been exercised in the solution of the elaborate mass of details connected with the hospital. No effort has been spared to secure appointments and equipment up-to-date in every respect, and in organization and operation, the hospital has been planned on the broadest lines based on the most advanced principles and thought. When the scheme has reached the completeness planned by its originators, a distinct step will have been made in mental hospital design.

* * *

However praiseworthy may be the sociological, medical and architectural aspects which alone combine to make this institution a hospital of first rank, it is in the methods of construction and erection, no less commendable, we believe, that the readers of the Contract Record are more particularly interested. It is a characteristic feature of the Provincial Government work that it uniformly houses its institutions in buildings of a distinctive character, both from an architectural and contracting point of view. At Whitby, the buildings are full of progressive and unusual ideas, not only as regards equipment but also as to materials of construction and their assembly. With the object of presenting matter of constructional interest, we have, in this article, endeavored to bring to the forefront a few of the practical methods that have proved outstanding features of the work.

To any observer of the undertaking, lay and professional alike, the most impressive aspect of the project is the methods of erection, handling and transportation, which are carried out to lengths rarely attempted in buildings of this character. The selection of plant, methods and equipment has been performed with infinite study and ingenuity, and a perusal of the article will justify the claim that the methods of construction are marked with an outstanding originality.

* * *

The value of Government organization has been shown at its best. Practically every detail of the work has been carried out under government supervision, with labor under government control and in many instances with materials of government manufacture. A matter deserving especial praise is the vast amount of original experimental and research work in connection with the development of the scheme and the production of the constructional materials. Careful studies were carried out on a multitude of details almost too long to elaborate. Another marked feature has been the degree to which detailed office study has been carried. Efforts were made to have as little uncertainty as possible in the field and with this end in view, office studies were carried out to an endless degree to eliminate field design. Proof of the efficacy of this idea is shown in the reasonable building costs.

One matter of inestimable value has been the very effective cost system that has been applied. The cost of every class of work has been carefully calculated and tabulated as soon as that work was finished. The result is that not only has the government an interesting collection of cost data, but the information gathered on a particular class of work has resulted often in a considerable reduction in the cost of further work of the same kind. As an example, the cost of a particular type of sidewalk was estimated, but after laying 500 square feet the unit costs of the work were determined and found to be considerably higher than the estimate. Before the construction was continued, the methods of work were analyzed and revised, with the result that in the remaining work the cost was brought down to the original estimate.

The above-mentioned characteristics give only the barest outline of the initiative that has been displayed on this work. They are taken up in greater elaborateness, with other matters of prime interest, in the article referred to. There are undoubtedly many valuable hints that can be drawn from the work, and above all, an indication is given of the extent to which Canadian manufacture can go in the production of materials never made here before.

* * *

Conditions arising since the war broke out combined with the greatly increased cost of labor and materials have produced difficulties in financing such a large institution. On this account there has been a tendency to reduce the appropriations and carry out the scheme on less extensive and less liberal lines. Indeed, there are some persons, fortunately not many, who are inclined to resent further expenditures, and who, under a misconception, believe the institution in its existing condition to be able, adequately and effectively, to serve the aims its instigators had in view. One other matter has apparently supported their ideas. The fact that the buildings already erected have been taken over by the Militia Department for military purposes has been construed as an opportunity to cease further operations. Nothing, however, is more likely to detract from the essential and basic principle that will govern the scheme's usefulness. Particular emphasis must be laid on the fact that the hospital is unfinished; that portion of it already completed is but the groundwork for a wider development. What remains to be constructed is beyond everything else, the essential part and so intimately are the various elements correlated that the omission of one limits the usefulness of all the others. What must be clearly realized is that it is not the cottage principle that makes the Whitby Hospital distinctive. There are dozens of cottage hospitals throughout the world, not taking second place by any means to that at Whitby. What forms the distinguishing characteristic, however, is the carrying of the hospital idea into all the buildings. The fact that the institution is a hospital and not a mere group of houses is the central idea, and with a realization of this there have been incorporated into even the cottages hospital features coupled with hospital organization and operation. The main hospital units, however, remain to be built. The opportunities for specialized medical treatment and research investigations are to be offered in the buildings of the hospital centre, which have not yet been constructed. Without them, the full value of the hospital will not have been realized. The work already done, excellent as it may appear, is but a cog in a large wheel; it is as good as useless until the whole is intact.

Dr. J. G. Davidson, of the University of British Columbia, in co-operation with Lloyd L. Davis, of the University of Washington, has discovered a process of distilling sawmill waste whereby it is believed that thousands of dollars will be saved.

Engineers Combining for Government Service

IN the last issue of the Contract Record under the heading, "The Engineer's Opportunity for Patriotic Service," we reported an open meeting that had been held at the Engineers' Club in Toronto of members of the local branches of all the technical societies represented in that city. At that inaugural meeting a committee was appointed composed, in the main, of one member each from the various technical organizations having members in Ontario. These gentlemen consented to act subject to the ratification of their appointment by the individual organizations.

This committee met on Tuesday evening, January 2, and discussed at length various lines of action that seemed to offer promise of real and useful results in the way of hastening our victory in the war. Professor J. C. McLennan, who is also a member of the recently appointed Industrial Research Advisory Council, outlined the work that body is planning and expressed the belief that the committee of engineers could work best through this Advisory Council, at least for the present. This plan commended itself to the committee and in all probability developments will follow along that line.

For the purpose of expediting the work of the committee, two sub-committees were named, (1) to draft a set of by-laws, and (2) to check up lists of technical men in the Dominion. A motion was also passed authorizing the secretary to communicate with all the technical societies outside of Toronto, suggesting that they take action similar to that of the Toronto engineers. Already as we go to press the secretary advises that a number of replies have been received, all endorsing the movement. It is believed that the whole engineering profession in Canada will stand solidly behind the plan, in which case it is certain that the movement must become a force in the war to-day and in the development and government of our country in the future.

This matter is worthy of the attention of every engineer in Canada, and it is urged that each and every member of the profession take a personal interest in furthering the scheme. The secretary of the Toronto committee is Mr. Wills Maclachlan, Excelsior Life Building, Toronto, who will be glad to receive suggestions or communications to place before the joint committee.

An Architectural Commission in Westmount

In May last the City of Westmount appointed an architectural commission to consider all building plans. The commission consisted of Messrs. J. S. Archibald, chairman; Robert Findlay, H. D. Macfarlane, and D. Norman MacVicar, who gave their services free. The object was to improve the beauty of the city from the architectural point, the commission having power to regulate the exterior appearance, height, etc., of all houses, public buildings, etc., and to examine the plans submitted. An appeal to the council may be made from the decision of the committee, which meets weekly. The work of the committee, says Alderman Shepherd, has proved of great value, and is likely to be more so in view of the fact that a large amount of land is available for building. A vote of thanks to the commission has been passed by the council.

Canada's exports of forest products for 1916 were valued at $53,899,809.

Municipal Waste Disposal Plants

Recent Developments in Design—New Reduction Process that Obviates Objectionable Features of Older Methods and Gives Superior Results

By Gustave R. Tuska[*]

THE following paper, presented recently before the engineering section of the American Association for the Advancement of Science, discusses the important considerations in the construction of municipal waste disposal plants and, more particularly, the improved processes that have been developed for handling such wastes, as exemplified in the new plant now being built for the reduction of the garbage of New York City. Comparisons are made with older processes as regards both methods employed and results secured. Objections to former methods with the advantages and disadvantages of the new process are presented from both sanitary and commercial aspects:

The growing public interest in the general recovery of by-products heretofore wasted and in the effort to avoid the destruction of any useful materials has been especially evident in the discussion on the disposal of municipal waste. This interest has naturally been extended not only to the processes and methods used in the disposal of such wastes, but also to the matter of the ownership of such plants—that is, whether they are to be municipally or privately operated.

From the standpoint of the public, however, every consideration in the design and construction of such plants should be subordinated to the question of their being built and operated according to the most sanitary methods. The first cost of the plant and its cost of operation should only be considered after the question of sanitation.

The municipal wastes above referred to consist of ashes, rubbish and garbage. In the matter of the handling of the ashes and rubbish there have been no marked improvements during the last few years. "Filling in" with the ashes and incineration of the rubbish still continue to be the best methods when these materials are handled separately. When they are disposed of in combination with the garbage, high temperature destructors are used. Except in the matter of some of the details of the design and operation of these destructors, there have been no important improvements made during the last few years.

Methods of Garbage Disposal

As to the disposal of the garbage of large municipalities, two methods in the main are used. First, disposal in the high temperature destructor furnaces referred to above, and second, disposal by reduction processes, in the course of which there are recovered from the garbage, grease and low grade ammoniates, both of which materials are of considerable commercial value. It is in the methods of reduction for the handling of garbage that the greatest improvements have been made in the last few years. Formerly, where successful reduction processes were used, they were only of two types—one, where the garbage was mechanically dried in hot air furnaces and the grease then extracted by means of a chemical solvent and the material then re-dried so as to produce a commercial product; second, where the garbage was digested, pressed and mechanically dried, the grease being extracted partly by pressing and partly by degreasing with chemical solvents.

These processes have been in use in all large United States cities where reduction of garbage has been followed, and in almost every case strong objections have been raised to the operation of such plants on account of the nuisance created. The main objections to these plants have arisen from the gases produced in the destruction of the garbage and from the gases discharged in the drying processes used in these plants.

A New Reduction Process

To obviate these objections a new reduction process has lately been evolved. The operation of this process is as follows:—The raw garbage is placed in a closed tank which is sealed air-tight. This tank or reducer is constructed with jacketed walls and jacketed bottom. Into these jackets the steam which is used in the reduction of the garbage is delivered, these jackets being so designed that it is impossible under proper operation for the steam to enter the tank or come in contact with the garbage. In the interior of this tank there is an agitating device operated by power from the exterior. When the proper charge of garbage has been placed in the reducer and the covers placed thereon, the tanks are sealed and the solvent is pumped into the reducer and steam admitted to the jacketed walls. The heat from the steam which is transmitted to the garbage through the walls of the reducer causes the evaporation of the solvent and the water in the garbage.

Garbage is usually composed of over seventy-five per cent. by weight of water. The steam heat vaporizes the solvent and the water from the garbage and these mixed vapors are drawn off from the reducer to the condenser. The economy in this method of evaporation rests on the fact that water is vaporized at a lower temperature when evaporated with a solvent having a low boiling point than when evaporated without such solvent.

Extraction of the Grease

The mixed vapors of the solvent and the water while in the condenser are there condensed to a liquid state and the water and solvent together are conveyed to a closed tank. Owing to the solvent being of lighter specific gravity than the water, the solvent and the water are separated by gravity, the solvent rising to the top from where it is drawn back to the storage tanks and then pumped back to the reducers and used over and over again. The condensed water which has been largely diluted owing to the jet condensers used, is discharged into sewers or waterways.

When the garbage has been thoroughly dried by this method, the solvent is pumped into the reducer and dissolves the grease. The solvent with the grease is drawn off into a closed tank or evaporator, heated by steam pipes, the steam being kept separated from the grease. The solvent therein is evaporated and carried to a condenser and again liquefied and carried to the storage tanks to be used again. After the grease has been extracted from the garbage in the reducer, it is further dried by means of the steam in the jacketed walls and is now in the form of de-greased garbage tankage which is used for fertilizer purposes after being ground and screened.

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Leakages Impair Proper Operation

It will be seen from the above description of the process that, if there are any leakages or veins in any of the tanks or piping where the solvent is handled, more or less of the solvent is lost, and thereby a substantial additional expense is imposed upon the operation of the system. It is evident, therefore, that it is to the financial interest of the owner of the plant to see that it is properly operated. Furthermore, under this system the garbage is at no time brought in contact with the atmosphere, from the time of its original entrance into the reducer until after over twelve hours of cooking; it is finally discharged therefrom as finished products, dried, sterile and practically odorless. These finished products are grease and the tankage above referred to.

Elimination of Odors and Gases

It will be seen from the above description that the process is one of straight de-hydration and from the time that the material is at the boiling-point, no further chemical action in the material takes place. No process of "digestion" occurs and therefore the odors and gases incidental to such a process are not created. Only the volume of gas contained in the raw material is driven out and only the essential oils of an extremely volatile nature are carried over in the current of steam and solvent vapor evolved. That little or no conversion takes place in the operation is shown by the fact that, in the de-hydrated material obtained at the end of the operation, there exists practically the same amount of unconverted starchy bodies as existed in the garbage at the time of its entrance into the reducer.

The condensed water contains all the gases evolved and has when fresh a slight odor of the mixed essential oils. Some traces of alcohol are detected in the effluent and a very small quantity of fixed oils is carried over. Any ammonia evolved, if it has escaped the acid in the garbage, is neutralized by acid carried over in the vapor. Whatever albuminoid ammonia exists in the effluent is carried over by mechanical entrainment as dust particles during the steaming out of the solvent.

The effluent from this process consists of almost pure water, this water being the condensed moisture drawn from the reducer while the garbage is being treated and from which the solvent has been extracted as completely as possible. The effluent is cold and gives forth no steam or vapor and is practically odorless, and as a result can have no undesirable effects when run into a large body of water.

The only other possible source of odor during the entire reducing operation would be from the odor contained in the air and gases mechanically included in the green garbage prior to its entrance into the reducer. These gases, plus the air in the reducer itself at the time of filling, are driven out by the first rush of solvent vapor. The entire volume of such gases is so small that no objectionable condition can be created by their discharge.

Tankage is Inoffensive

As regards any odor from the tankage, when this material is taken out from the reducer, it is in a dry condition and quite warm, and when it is first exposed to the atmosphere, there is momentarily a slight odor of dried material best described as a smell of stale gingerbread, due to the essential oils rising from the material when hot. No gases are generated, and this odor lasts only during the period of emptying of the reducer and is not offensive nor perceptible outside the building.

It will be seen that in the operation of garbage treatment by this process there is no period of gas generation and no large volumes of decomposition and combustion gases given off as in digestion and drying. There is therefore no necessity for condensing, washing or trapping odors or gases.

A further improvement has also been made in the solvent employed in the de-greasing process. Heretofore, gasoline has been used for this purpose, but it has been proven that a more economical operation and elimination of the danger of explosions is obtained by the use of a kerosene distillate, obtained by the treatment of ordinary kerosene in a vacuum still.

Higher Operating Cost Offset by Superior Results

The cost of a plant operating on the above system is from twenty-five to fifty per cent. more expensive than one on the digestor system. The cost of operation per ton of garbage by this system is also considerably higher than by the digestor system, the labor cost being about the same but the cost for fuel and solvent being considerably greater. As against this increased cost, we have superior sanitary advantages and a considerably greater value of recovered products. By the use of this process a larger grease recovery is obtained, also a more valuable tankage. Where the digestor system is employed, the potash contained in the vegetable fibre, being soluble, is lost in the discharged water. With this process, it remains in the tankage amounting to over one per cent. by weight in the dried product.

Furthermore, with the digestor system the largest portion of the water contained in the garbage is removed by pressing. This water, discharged from the presses, carries eight per cent. of solids by weight and is the most valuable for fertilizer purposes as it contains all of the ammonia and potash which is water soluble. All such material is recovered by this process. Furthermore, with the digestor system where direct heat dryers are used, there results a large loss of solids (tankage, grease and fibrous material), averaging about twenty per cent. of the total weight of tankage fed into the dryer. This loss is due to carbonization of the materials named and results in various odors and gases. This loss, with the resultant gases, is avoided by this process.

The Largest Plant in the World

The practical operation of this system has been demonstrated by the plants handling the garbage for the cities of Los Angeles, California, and New Bedford, Mass., and in the new plant now being constructed for the handling of the garbage of the city of New York this improved process will be employed. The New York city plant will have a capacity of over two thousand tons of garbage per day and will, therefore, be the largest of its kind in the world. Its construction will be of further interest in view of the fact that every possible improvement in the handling of garbage will be installed so as to enable the disposition of the garbage to be made in the most sanitary manner.

Further improvements have been planned in the transportation of the garbage to the plant. The barges in which the garbage will be transported will be so constructed that all water, drained from the garbage in transit, will be collected in a special closed tank located at one end of the barge. On the arrival of the barge at the plant these tanks will be automatically emptied by attaching a steam connection thereto, steam pressure blowing the drained water to tanks on shore, the steam also so acting as to disinfect the tanks. While in transit, the barges will be covered by specially treated waterproof covers, so attached so as to prevent the discharge of any of the garbage from the barges.

Method of Handling the Garbage

A canvas apron will extend from the barge to the dock to prevent any of the garbage falling in the water during the unloading of the barge. This apron is so designed that it will automatically move with the barge when the same is moved along the bulkhead to bring the various portions of the load under the hoist.

All conveyors in the plant handling raw garbage are of the closed type to minimize the discharge of gases into the atmosphere.

From the above description it is evident that the introduction of this improved process in plants designed for the handling of municipal waste although more expensive in first cost and cost of operation, insures a thoroughly sanitary disposal of such wastes, obviates nuisances and obtains a maximum recovery of commercial products.

Bituminous Mortars for Pavement Fillers

Pitch-sand and Asphalt-sand Mastics for Use in Joints of Stone Block, Brick and Wood Block Roads—Proper Proportioning and Application

By Philip P. Sharples*

MANY different joint fillers have been experimented with in the attempt to make street pavements of the block type waterproof. When stone block and brick pavements were first constructed the blocks were laid on a sand cushion and the joints were filled with sand or with gravel and sand. But later, when a concrete base was furnished, it was found that a better joint filler was necessary, and the gravel-pitch joint was introduced. This was simply a joint into which gravel was swept until it was full, then pitch (coal tar) was poured in in sufficient quantity to fill the voids and make a waterproof joint. In the case of brick pavements the joints were filled with a straight-run coal tar pitch without the addition of sand or gravel.

These earlier block pavements had joints that averaged three-quarters of an inch in width. It was a simple matter to sweep gravel into such joints. With the advent in 1911 in New York of the carefully-dressed granite blocks, the joints of which were less than one-half inch, came the necessity for some means of filling the joints other than with gravel.

John A. Brodie, city engineer of Liverpool, England, had already solved the problem by using his Pitchmac mortar for joint filler, and in 1913 a pitch-sand mortar was used in New York for the first time.

Specifications for Pitch-Sand Mastic

After three years of successful use in New York the American Society of Municipal Improvements, at the 1916 meeting, adopted the following specification covering pitch-sand mastic:

"The joint filler used shall be the paving pitch hereafter described, thoroughly mixed with as much hot, dry sand as the pitch will carry, but in no case shall the volume of the sand exceed the volume of the pitch. The sand shall be fine and clean, and all of it shall pass a 20-mesh screen. It shall be heated to a temperature of not less than 300 degs. F. nor more than 400 degs. F. and shall be between these limits when mixed with the paving pitch.

"The paving pitch shall be heated in kettles properly equipped with an approved thermometer, which shall register the temperature of the pitch.

"The mixture shall be flushed on the surface of the blocks and pushed into the joints with suitable tools, re-flushing or re-pouring, if necessary, until the joints remain permanently filled flush with the surface of the pavement. As little as possible of the mixture shall be left on the surface.

"The tar pitch shall comply with the following requirements:—

(a) It shall have a specific gravity between 1.23 and 1.33 at 60 degs. F.

(b) It shall have a melting point between 115 and 135 degs. F. determined by the cube method in water.

(c) It shall contain not less than 20 per cent. nor more than 35 per cent. of free carbon insoluble in hot benzol or chloroform.

(d) It shall contain not more than one-half per cent. of inorganic matter.

(e) It shall be free from water.

(f) It shall have a ductility of not less than sixty centimeters at 77 degs. F.

"The tar pitch shall be used on the work at a temperature of not less than 250 degs. F. and shall at no time be heated above 325 degs. F.

"It shall be delivered where directed by the engineer in time to allow for examination and analysis.

"In applying the filler, care shall be taken that the pavers are closely followed by the filler gang, and in no case shall the paving be left over night, or when work is stopped, without the filling of the joints being completed. In case rain stops the filler gang before its work is finished, the joints shall be protected by the use of tarpaulins, or other means, to keep out water. Under no circumstances shall the filler be poured into wet joints."

Importance of Proper Proportions

The first work in New York was done in 1913-14. About 100,000 square yards of improved granite block pavement were filled with pitch-sand mastic. While the specifications called for a mixture of the two ingredients in equal proportions by volume, "or as much sand up to that proportion as the pitch will carry," it is probable that the percentage of sand actually present in the mastic was not over thirty. And it is likely that in many instances it was far less than that. It is certain that in one or two cases not over 5 per cent. of sand was present.

The presence of fine material in any mixture stiffens the mixture, and it was expected that the sand would stiffen the pitch, thus making it more stable in the joints. Accordingly, a pitch of lower melting point than ordinarily used was specified. Where a sufficient quantity of sand was introduced into the mix no trouble was experienced, and the streets to-day are in ex cellent condition. Where insufficient sand was incorporated, however, there has been trouble with the pitch running to the gutters in the hot summer weather.

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Faulty Methods of Mixing and Applying

The fault lay in the manner of mixing and applying the filler. Originally the mixture of sand and pitch was made in a small bucket, by stirring with a slotted iron paddle. Each joint was filled individually by pouring from the bucket. Considerable time is taken to fill joints in this way and the sand and pitch tended to separate, so that some joints would be filled with nothing but pitch, and a large quantity of sand would be left in the bottom of the bucket which the workmen would not take the trouble to pour out but would leave to be mixed in the next lot. The result was that the filler was not uniformly what the specifications called for.

In 1914, in Cleveland, Ohio, a pitch-sand mortar was tried out on brick. It was carefully mixed and carefully poured and the result was very satisfactory. About forty per cent. of sand was the average in the mixture. Shortly after this, the joints of a brick paved alley in Columbus were filled with pitch-sand mastic which was mixed in a concrete mixer. Various percentages of sand were tried, and it was found that two parts of sand to three of pitch gave the best results from the point of view of application. A half and half mixture was too stiff to successfully apply. The sand was not very fine and this accounted for the fact that the half and half mixture could not be worked. After a year and a half the joints are all full of the mastic, and the alley is in excellent condition. It should be noted here, however, that on this job the method of pouring the joints was not followed. Instead, the mastic was dumped onto the brick and pushed into the joints with squeegees. This insured the filling of all the joints. It also insured a uniform mastic. There is no opportunity for the sand to settle out of the pitch as there is when the joints are poured individually.

Asphalt-Sand Mastics

While this work was going on in Cleveland and contiguous territory, New York was trying the experiment of an asphalt-sand mastic. The specifications of the American Society of Municipal Improvements given above are practically the same as those of New York for this work. The difficulty of obtaining a good mixture of sand and asphalt was even more pronounced than when pitch was used. Records indicate that sometimes as little as two per cent. of sand was found in samples taken at random from joints. These streets, however, present a very good appearance on the surface, and owing to the higher melting point of the asphalt no trouble has been experienced from running to the gutters. Openings show, however, that the joints are not as well filled as with coal tar pitch and that the asphalt has not adhered very well to the blocks. In 1916 permission was given the contractors to follow the Columbus method of flushing the mastic on the pavement and then forcing it into the joints with squeegees, hoes or shovels. This has resulted in very much better work. A satisfactory mastic can be made and applied with a minimum of delay. There can be but little separation of the materials.

Successful Use of Pitch-Sand Joints on Heavy Grades

The foregoing specifications should not be blindly followed. It is essential that all conditions be known before a specification for any particular location be drawn. A very successful application of pitch-sand mastic was made in Englewood, N. J., on a street which has a grade of 14 per cent., and is paved with improved granite block. The pitch in this instance was 145 degs. F. melting point, and a mixture of 50 parts of sand with 50 parts of pitch was applied. The flushing and squeegeeing method was followed. No separation of materials took place, and no running of the mastic has been observed, although the street has been exposed to the hot sun. Owing to the grade and the nature of the traffic, it was deemed advisable to use a pitch of high melting point. The results have justified the departure from the usual specifications.

From observation in various parts of the country the conclusion is reached that not more than 50 parts of sand by volume can be mixed with the same amount of bitumen and secure an economical job. Further, if the work is carried on in very cold weather, not over 40 per cent. of sand can be used. Not even this proportion can be used in every kind of weather when the pouring method of filling joints is employed. Further, it is only with sand, all of which will pass a 20 mesh sieve, that a half and half mixture can be obtained that will work into the joints.

Hand Mixing is Best and Cheapest

While numerous attempts have been made to construct machines that will mix the materials, hand mixing still seems to be the best and cheapest method. The mixing may take place in a wheelbarrow, or preferably in a two-wheeled concrete carrying cart, and the best implement for mixing is a large hoe. The mastic can be wheeled immediately to the point of application, may be given an additional tempering with the hoe, and is then poured onto the pavement and immediately pushed into the joints. Concrete mixers have been used for mixing, but their operation is not as cheap as hand work, although from the mixing point of view they are satisfactory.

Mastic Fillers for Lug Wood Block Pavements

A very recent use of mastic has been in filling the joints of lug wood block pavements. The first work of this kind was done in Milwaukee in June, 1916, on the 16th Street Viaduct. A pitch of 145 degs. F. melting point was used, and a fine lake sand, heated to 400 degs. F., was mixed with the pitch. A 50:50 mix was used throughout, and no difficulty was found in getting it into the joints. It is too soon to say how the filler will behave, but to date it is perfectly satisfactory from every point of view.

When a contractor takes his first job of bituminous mortar work he fails to realize the importance of having the sand as hot as the specifications require. The consequence is that he claims he cannot obtain 50 per cent. of sand in the mix and make it work. It is absolutely essential that the sand be at least 250 degs. F. when it is mixed with the pitch, and it is better if it is 350 degs. F. If asphalt is the bitumen used, it will be better if the sand is 400 degs. F.

Summary

Those bituminous mortar fillers that have given trouble to date have done so because not sufficient sand was originally mixed with the bitumen. A fine sand gives much better results than a coarse sand, and more of it can be introduced in the mastic. By properly heating and applying, a mastic with equal parts, by volume, of sand and bitumen can be forced into the joints of block pavements. For special conditions, special grades of bitumens must be used. Hand mixing is cheaper than machine mixing, and as good. The pouring method should be entirely dispensed with and the flushing and squeegeeing method substituted.

Hospital for the Insane, Whitby

Buildings Arranged in Three Main Groups—Accommodation for Fifteen Hundred Patients—Most Modern Construction Throughout — Extensive Heating, Lighting, Sewage and Water Systems—Planned and Built by the Ontario Government—Main Constructional Features, Many of them Unique, Described and Illustrated in Detail

IN 1912 the Ontario Provincial Government undertook studies regarding the treatment of the insane with the idea of promoting an institution where mental diseases could be most effectively treated. Within recent years this province has become noted for the promulgation of social reforms of great importance to the welfare of those dependent on provincial care. Striking evidence of this is given by the creation of the Provincial Reformatory at Guelph, which is regarded as a model institution for the reform and care of criminals and law-breakers. In accordance with this principle, the province decided to extend its energies further and to care for its insane on the same advanced lines, developing a hospital that would scarcely resemble at all the old-fashioned out-of-date asylum, but would be the last word in providing helpful treatment for the mentally afflicted.

A careful study was made of hospitals and institutions in Europe and America for the purpose of obtaining the best ideas and the most advanced thought and practice. It was the intention that Ontario should have a hospital for the insane second to none so far as arrangement, equipment and effectiveness were concerned, and that the mistakes of other places should not be repeated. At the same time, although much knowledge was gained from the examination of outside hospitals for the treatment of the insane, it was felt that the principles laid down in other countries must not be followed too slavishly, since in Ontario there are certain problems that call for different treatment due to our local conditions. The result of these extensive and thoughtful investigations has been the building of the new Provincial Hospital at Whitby, Ont., which will undoubtedly be regarded as a model institution involving the best ideas and most advanced thought on the treatment of mental disease, and the plan of which will incorporate the best that has been revealed by a review of work done in existing institutions, modified, as seen fit, by a careful study of Ontario's particular problems.

Location and Plan

The new hospital, a large part of which is now ready for occupation, is admirably located south of the town of Whitby, Ont., on a gentle slope facing Lake Ontario and having the advantage of an open south-east exposure. The hospital is located in the centre of a prosperous and fertile farming district, and in addition, is excellently served by railway and water facilities. The district is regarded as exceedingly abundant in natural beauty. The situation is thus ideally suitable for hospital purposes.

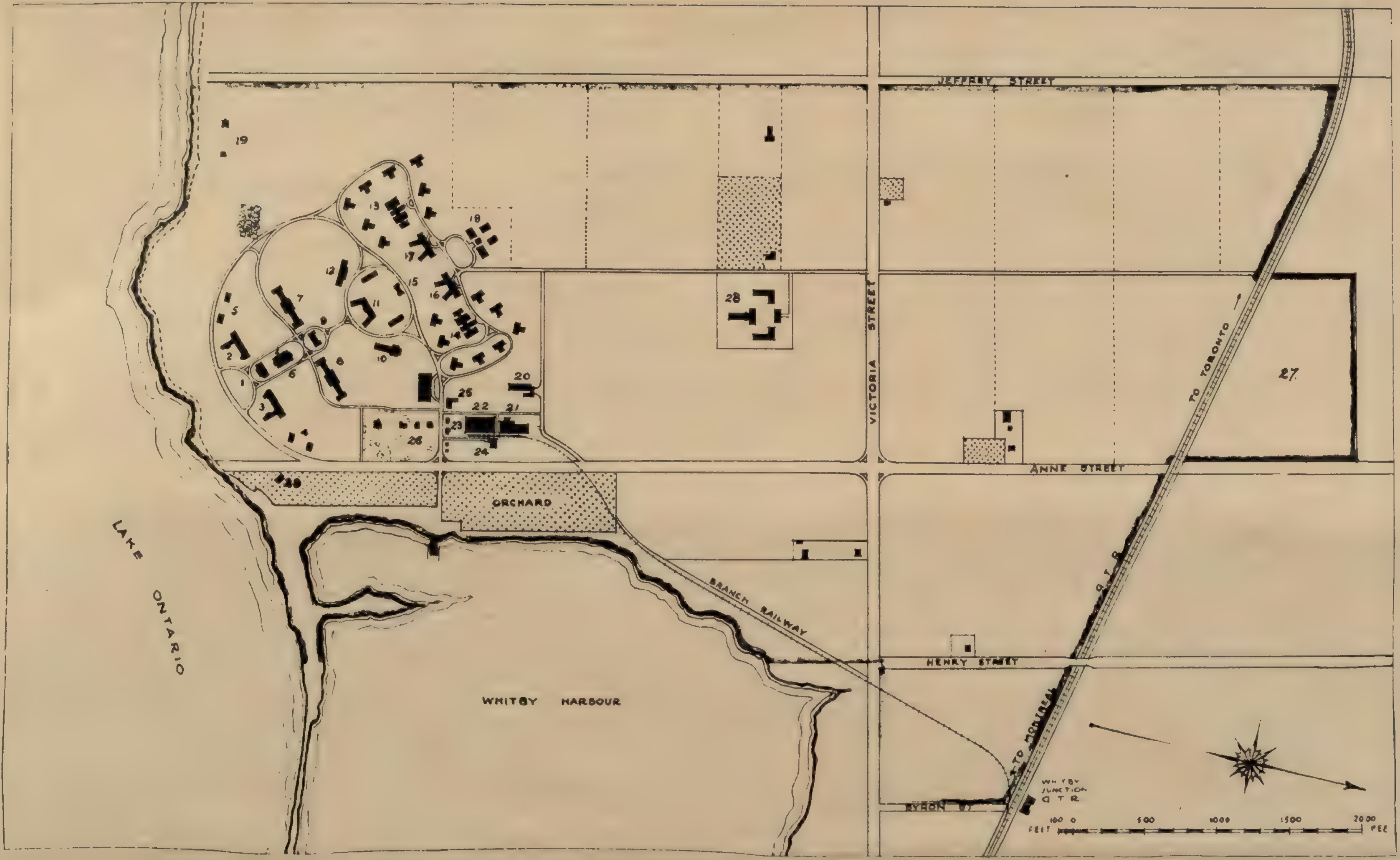
In planning the hospital, the village system has been adopted in principle; that is, a series of industrial cottages has been developed rather than one single building that might possess too much of the institutional or asylum appearance and atmosphere.

Unexcelled Equipment and Arrangement

The complete plan calls for a hospital extensive enough to accommodate fifteen hundred patients, with a systematic and orderly arrangement of buildings in three main groups or centres. The first group, which has not yet been erected, will form the principal hospital centre and will be situated nearest the lake front. This centre will include two reception hospitals for men and women respectively, reserved for observation on incipient cases; four convalescent cottages; two hospitals for recurrent acute cases and a central kitchen and dining room. As in the other centres, the buildings for female and male patients are arranged about a centre line that has a south-easterly direction. The hospital centre is a distinct unit from what must be called the industrial group, which includes two cottage centres, and provides for patients who do not require special medical treatment as supplied in the hospitals.

Each of the two cottage centres consists of eight cottages, accommodating about sixty patients each with an infirmary for about 130 patients and a central dining-room and kitchen. Other buildings include an isolation group, a surgical and pathological building, a church and hall, a recreation building, nurses' home, laundry, stores, greenhouse, farm buildings and buildings for officials, employees and attendants. The power house, workshops and sewage disposal buildings are located as far as practicable from the main hospital.

The hospital buildings are amply equipped for the efficient care and treatment of all types of mental diseases. The domestic arrangements have been studied with detailed care and every provision has been made



Plan of buildings and farm at the Provincial Hospital for the Insane at Whitby, Ont.

Key to plan:—1. Administration building; 2. Reception hospital, men; 3. Reception hospital, women; 4. Convalescent cottages, women; 5. Convalescent cottages, men; 6. Kitchen and dining-room, hospital centre; 7. Hospital, men; 8. Hospital, women; 9. Surgical and pathological building; 10. Church and hall; 11. Nurses' home and annexes; 12 Recreation building; 13. Cottage centre for men, kitchen and dining-rooms in centre; 14. Cottage centre for women; 15. Doctors' residence; 16. Women's infirmary; 17. Men's infirmary; 18. Tubercular and isolation hospital; 19. Sewage disposal works; 20. Greenhouses; 21. Power plant; 22. Stores, workshops, etc.; 23. Employees' cottages; 24. Ice storage house; 25. Attendants' home; 26. Residence for officials; 27. Garden; 28. Farm buildings; 29. Sewage pump house; 30. Laundry.

to procure bright and cheerful apartments and to ensure freedom for the patients, within bounds, and yet under perfect supervision of the officials.

Whitby differs from other institutions in that the hospital idea of nursing and treatment is being carried into all its buildings, and that while the cottages for patients who are physically well enough to be occupied daily have none of the all too common institution appearance and atmosphere, but are rather of a domestic type of architecture, they still preserve internally a hospital character in the arrangement of wards, single rooms and treatment rooms, which will call for the highest degree of nursing skill.

One of the distinctive features of the location and arrangement of the buildings is the care that has been taken to ensure that the maximum amount of sunlight enters those rooms and wards occupied by patients. The importance of orientation of all buildings has been carefully considered and they have been deliberately located so as to receive the greatest possible benefits of sunlight. This was the basic idea in the development of the scheme.

A complete sewage disposal and treatment plant has been provided to take care of the needs of this hospital community, and a power house very completely equipped will provide heating and lighting.

At the time of writing, work is almost completed on the second group of cottages, and on the infirmaries for both the centres. The first cottage centre has been furnished and is being occupied. The sewer system and sewage disposal plant is finished and the power house is supplying heat to the buildings in use.

Interesting Constructional Methods

In connection with the erection of the buildings many admirable and interesting methods of construction were adopted that embrace many features worthy of consideration and that show the care and study that has been given to every detail by the architects and builders. In the succeeding paragraphs we describe in more or less detail the methods that have been employed and elaborate upon some of the special features that distinguish the work of construction on particular buildings. The interior appointments and furnishings have been selected with almost infinite care and are a credit to the organization that has created this institution, but no less commendable is the work which the construction organization has carried out. The whole of the work, from its inception to completion, has been carried out under the direction of the Provincial Secretary's Department.

Materials of Construction

As already indicated, the buildings constituting the new hospital have been designed to eliminate the prevalent coldness of the institutional type of asylum. For this reason, along with others dealing more directly with the medical treatment and supervision of patients, a group system has been adopted. In the design of the buildings the architecture is of a rather domestic type intended to accentuate the home-like characteristics of the institution without detracting from its intended purpose. The exterior appearance of all the structures is pleasing without being pretentious, and the scheme is made harmonious as a whole without unnecessary or useless expenditure.

The entire project exemplifies a very effective application of brick, tile, concrete and stucco, and their harmonious combination and blending to produce an attractive appearance. From an architectural point of view the hospital thus appeals to good taste, while from an engineering and constructional viewpoint there are features of distinctive importance.

Government Clay Plant Supplies Clay Products

One thing that has contributed very materially to the success of the operations has been the establishment of a Government clay plant at Mimico, where practically all of the clay products used at Whitby have been produced. These include the hollow terra cotta, roofing and flooring tiles, drain tiles, as well as special clay shapes to meet individual requirements. Even the tapestry bricks are made at this plant. The success attending these operations has resulted in the application of clay materials to a greater extent, perhaps, than is usual for buildings of this character.

With the exception of some few basement walls of concrete, all walls and partitions for all the buildings, except the power house, have been constructed of hollow terra cotta with brick trimmings. The hollow tile blocks are made in thicknesses varying from 4 inches to 12 inches to suit walls of varying requirements. The exteriors are finished in stucco. Tapestry brick has been used at the corners, bases and friezes, in verandah pillars, and so on. Common brick has been used for wall construction in place of tile at any angles, to bond the tiles, and at points where an extra concentration of load occurs.

Excavating by means of scrapers attached to an endless rope. Hoisting engine drags scrapers forward, and by reversing, pulls them back

Hollow Concrete Beams for Floors

The floors are built of factory-made beams of concrete, cast in the required lengths and sizes, and made on the Siegwart principle, for which the Provincial Government has secured the rights to manufacture in Ontario for Government work. These beams are hollow and on this account produce a light floor but of great strength. Since they are made in a special plant and cured before placing, no form work is required, the process of building up a floor simply consisting of setting the beams in place on the supporting walls in a continuous row. The sequence of operations is thus to build the terra cotta walls to the floor line, lay the floor beams and continue the wall. This type of concrete beam is also being used for stairways, the design obviously accommodating itself to ready application for this purpose. For flat roofs such as are installed on the infirmaries, the Siegwart beams were also used.

For the manufacture of the floor beams a special plant on the site was designed which presents special features of interest described in detail in later paragraphs. Not the least valuable merit of this type of floor construction has been the economical cost of manufacture and installation, there being approximately a fifty per cent. saving, it is claimed, over more conventional designs. Before the beam factory was operating effectively some combination hollow tile and concrete floors were installed, but the hollow concrete beams have now superseded these exclusively. The joints between the beams are grouted with cement mortar to produce a monolithic effect. In constructing the floor, if a space finally remains which is too narrow for the insertion of another beam, poured concrete is used. In this case, a form is built and reinforcement placed. Incidentally, poured concrete is also made use of in such parts as window lintels. Further details of beam design and manufacture are given in later paragraphs.

Mention has already been made of the use of concrete beams for flat roofs. All sloping roofs are of a slow-burning wood construction covered with red roofing tile.

The rafters used in the latter case are built up of three or four planks 2 in. x 8 in., spaced at 6, 8 and 10 ft. centers. These rafters were assembled and fitted in the factory according to standard designs previously worked out and were installed in accordance with a key plan.

The Power House Wall

Structural steel framework finds application in one building only (the power house), although rolled shapes are used to carry the floor beams in certain other cases where the spans are excessive (over 20 ft.) or to support partitions that are not continuous. A special feature of the power house is its wall construction. These walls are made up of ferro-dovetail sheets carried on the structural frame, and plastered inside and out with 1½ inches of cement mortar applied with a cement gun. This mortar is then given a coating of waterproof paint on both sides. The mortar mix used for plastering the power house walls is 1:3½ with one-tenth hydrated lime. This makes an admirable wall—fireproof, strong, cheap, and the metal is amply protected against corrosion.

Basement of infirmary, illustrating use of hollow tile for exterior walls and partitions. Steel sections, as shown, carry the partitions that do not begin in the basement

In all other buildings the exterior walls are stuccoed, and the interior walls plastered, with an alca lime stucco mixed in the proportion of five parts sand to 1 part of a 3 to 1 mix of alca lime and cement. Plastering operations have been immensely facilitated by the use of the cement gun, which applies this material quickly and effectively.

All sand and gravel used on the job has been procured from the lake shore on the site at a considerable saving in cost over transported materials. Frequent tests have verified its cleanness and suitability for concrete, and for roads and sidewalks throughout the hospital area.

Materials of Government Manufacture

In putting on the finishing touches, tile products have been effectively adopted. For floors and stairs, for example, the concrete beams are surfaced with a red quarry tile and the inside window-sills have a tile finish. Unusual shapes have been developed for special purposes, e.g., cove bases to eliminate dust catching corners at the junction of floors and walls, nosing for the edges of stair steps, round-edged tiles for window stools, as well as a variety of special shapes for purely decorative purposes. All these are products of the Government plant at Mimico.

Hollow tile blocks are used for all walls, including basement walls, as shown in this illustration. Corner bonding is with brick. All brick and tile are products of Government clay plant at Mimico

The wood trim, doors, sash and furniture are produced at the factories of the Ontario Reformatory, Guelph. Other materials, more of a furnishing nature, such as shelving and racks, are also manufactured there. The lime, both alca and hydrated, is likewise a product of the Reformatory.

In erecting the buildings, every precaution has been taken to secure protection from the hazards of fire. It has been already noted that the wall and floor construction is of an absolutely fireproof character. The roofs are slow-burning wood, tile-covered, but the fireproof ceilings provide ample security. The layout of the buildings has been arranged to provide convenient access to all balconies in case of fire.

Scope for Decoration

The type of architecture and construction that has been selected affords great scope for the employment of decorative ideas and no effort seems to have been

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spared to apply aesthetic refinements without involving anything expensive or pretentious. An extensive use is made of tile patterns throughout the exterior walls, and the great variety of color of the tile products is made effective use of. The design of the brick work has been arranged to add to the architectural composition of the buildings. The coloring of the tapestry bricks has been adapted to the production of pleasing designs, while careful application and combination of header, stretcher and diagonal courses, as well as the use of panelled effects give commendable aesthetic results. An example of a pleasing departure from the conventional is found in the power house and cold storage plant, where a double stretcher with unpointed joint alternates with a single header, using a wide rough pebbled joint.

Placing hollow concrete floor beams in position on ground floor with the use of a light railway which runs directly onto the building and carries materials right to the workmen

---

Handling of Supplies

Perhaps the outstanding feature of the work of construction on the Whitby Hospital is the detail with which the handling of materials and supplies has been planned. There is every facility for economical and rapid transportation and handling of all raw and finished materials, and no effort has been spared to secure labor-saving and time-eliminating processes and devices. These attempts are entirely beyond the usual methods adopted in structures of a similar character. This planning has resulted, it is claimed, in a very great saving in cost in comparison with contract prices.

Light Railways Handle Materials

The widespread area of the work practically put ordinary methods of handling material out of the question; for this reason a completely equipped standard industrial railway was installed. About five miles of track are included with one dinkey and a full complement of dump, flat, and box cars. This railway serves all buildings and every portion of the site where construction work is being carried on. The result is that any supplies whatever can be quickly and conveniently carried to the necessary spot in all weathers.

To carry brick and tile to the masons, there are lighter railways equipped with push cars into which the bricks are loaded from the dinkey train and moved right onto the buildings, where the walls are being constructed. These light railways are even installed on the upper floors, and cars being raised by hoists. The advantages of such equipment are obvious.

Shops at the Site

Well-equipped shops where work of almost any nature can be performed have been erected. The woodworking shop is provided with standard machinery, such as band saw, ripper, mortise and tenon machine, lathe, planer, jointer, swing cut-off, dado-head, and sticker. This shop has been erected as a field shop, intended for repair or alteration work or work that cannot be laid out beforehand.

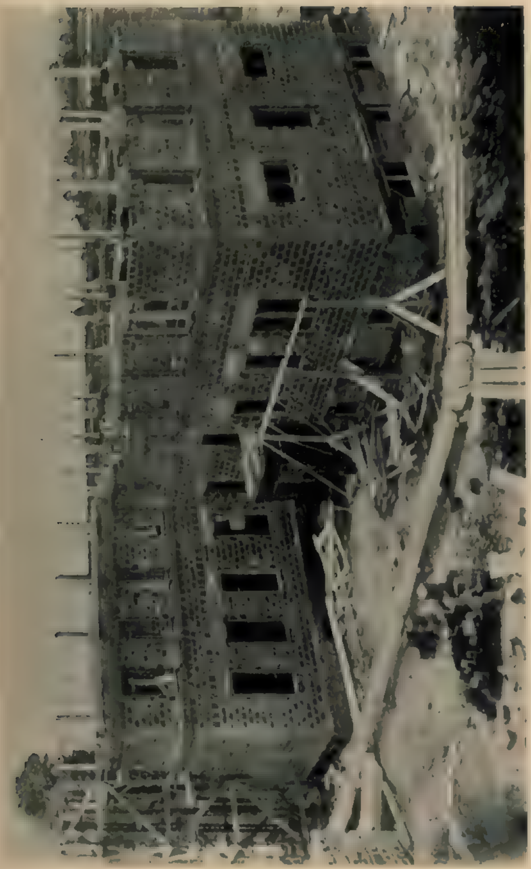
A blacksmith shop with the usual equipment takes care of all forging work, metal work and horseshoeing for the 18 teams on the job. For the sheet metal work there is a tinsmith shop. A pipe threading shop with a full complement of threading machines, tools and dies can thread pipes up to 6 inches in diameter.

Labor Saving Devices

At various points on the work a number of labor-saving devices are applied. One particular example of this is the use of Gilbreth scaffolds. These were fully described in the Contract Record of December 6th, page 1156. They are adjustable scaffolds that can be raised very quickly while the workmen are carrying on their work. They are easily erected, instantly available and readily transported. They have been used throughout for the erection of the walls and have proven eminently satisfactory. The use of poles and trestles is eliminated and the installation is much neater than the ordinary arrangement of scaffolding.

Gilbreth adjustable scaffolds facilitate building operations

Interior of a room in a typical cottage, showing use of government-made clay products for floor tile and brick fireplace, also government-made furniture



A building in course of erection, showing tile wall construction. Light railway for handling materials is shown also Gilbreth scaffolds on upper floor

Entrance of one building showing exterior appearance. Walls are of tile covered with stucco applied with a cement gun. Tapestry bricks are used for bases, friezes and quoins as a color offset to stucco

A staircase made of hollow concrete beams with tile covering

They have also been used on outside work for the application of the stucco.

Other devices were originated that proved equally valuable. For example, the application of stucco on the outside of the walls with the cement gun is interfered with considerably by the poles of a pole scaffold and a swing scaffold was devised to overcome these objections. This scaffold consists of light wooden frames (supported on the roof) suspended from which are brackets that carry the platform. The point of suspension is well back from the edge of the cornice, so that there is no cantilever action and the wooden frames need no counterweights to hold them. (See illustration). The platforms are composed of two 2-inch by 6-inch planks on edge, across which are laid ⅞-inch slats, 2 ft. long. The brackets on which these are carried are forged of iron and made high enough for a man to pass through. A hook on the top accommodates a double pulley block, while a triple block is carried on the supporting frame. This gives a 5 to 1 advantage. The scaffold can be raised or lowered by the men on it, the ropes fastening to a hook on the bracket. The platforms are 16 ft. long supported at about 14 ft. centers. By the use of this scaffold, the wall is made more accessible to the cement gun, since work is unencumbered with poles. It gives a clear field of operation for the gun manipulator and at the same time allows the finisher to stand close enough to float the surface. The difference between this swing scaffold and the ordinary type lies in the means of support. The wooden brackets are much more easily handled than the usual iron hooks. This type of scaffold is, of course, only applicable to flat roofs with projecting cornices.

In addition to the equipment already mentioned there is a large number of derricks of all types, hoisting engines, steam shovels, mixers, etc., to facilitate building operations.

The Concrete Beam Factory

The plant for the manufacture of the hollow reinforced concrete beams already referred to constitutes one of the main features of the entire scheme, not only because the design and manufacture of the beams are of unusual interest, but because, associated with the plant, are many other processes such as sand and gravel pitting, screening, mixing, sorting, placing and the matter of transportation, which are intimately related to the first mentioned process. In discussing the manufacture of the beams then, reference to the other matters is not out of place, and the entire process will be taken up in order.

Sand and gravel are obtained from the shore of the lake on the hospital property. A clam-shell dredge digs the material from the lake bottom just below the water line. It is transported by means of 3-yard dump cars on the industrial railway to the screen house, where it is dumped into the hopper of the rock crusher which breaks large stones to a ¾-inch ring size. A bucket conveyor carries the material to the top of the screen house and shaker screens separate the pit run material into sand and stone. Formerly three screenings were made, pea gravel being also separated. Two screenings are now, however, found sufficient for most purposes. The capacity of the screening equipment is forty cars, or 120 cubic yards per day. From this, thirty cars, or 90 cubic yards, will be sand. Frequent examination has showed this sand to be of superior quality and free from any foreign matter likely to detract from the strength of the finished concrete. As a result of about fifty tests, an average of less than two per cent. clay has been obtained.

After screening, the sand and stone are chuted from the screen house and carried by a chain bucket conveyor to the two storage bins in the Siegwart beam factory. It is estimated that sand and stone cost 18c to 20c per cubic yard to place in the bins.

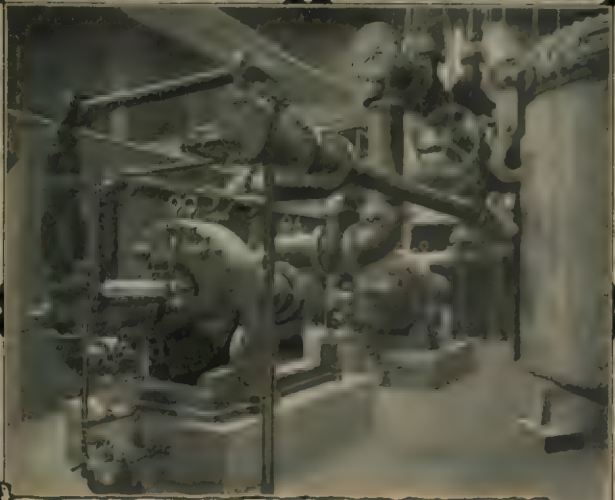
Excavating sand and gravel from beach on the site with clam shell and loading into dump cars. The industrial railway with five miles of track serves every part of the hospital area

The Beam Factory

The ~~building in which~~ the Siegwart floor beams are manufactured houses all of the equipment necessary for mixing and pouring the concrete and for handling the beams prior to storage and placing. The building is a wooden structure, at one end of which is located an electrically-driven half-yard mixer with the overhead sand and stone supply bins already spoken of. Gates control the chutes from the bins and to ensure correct proportioning a measuring box is employed. The mixer is located on a platform on which the cement is also stored. An electrically-operated skip runs the whole length of the building and carries the wet concrete to the forms.

The main working space is about 170 feet in length and the floor is divided into 12 beds, each one accommodating 9 to 10 beams of average width. To manufacture the beams a thin layer of concrete ¾-inch thick is poured on the bed and the collapsible steel moulds, used to produce the hollows in the beams, are oiled and set on this layer and properly spaced. To these cores are solidly attached the steel reinforcing bars. The cores are made of steel of various lengths and cross sections. By an ingenious mechanism the moulds are partly collapsible so that they are easily removed. After these are set in the correct position, concrete is poured to the required depth, care being taken to completely fill the space between the moulds. After initial set has taken place a special cutting machine separates the mass into beams of the required width, the centre lines of the beams having been previously marked. Beams 20 ft. 6 in. in length or shorter can be made.

The cutting machine spans the beds and moves



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backward and forward along rails. The knives of this machine are lowered by a hand-operated crank and gearing. A box placed alongside the knives contains dried sand which is automatically deposited between the beams to prevent their becoming cemented together. The knives are provided with ribs which carve a series of grooves in the vertical façes of the beams, so that when the beams are placed in a building, the grouting deposited in the joints forms a saw tooth connection between the different units making the floor a true monolith. As these corrugations are diagonal in direction, the two blades converge toward the centre so as to follow these grooves as the beams are cut.

A layer of sand is now sprinkled over the top of the first row of beams and a second row of beams is made as before. As many rows as desired are produced in this way, one above another. The capacity of the beam plant per day is 200 to 240 beams.

After twenty-four hours the cores are removed and the beams are then allowed to cure for seven days on the floor. They are then removed to the storage yard outside the building or to the building where they are to be used. A travelling chain hoist picks up the beams and places them on cars which run directly into the plant.

Prison labor has been made use of in this part of the project and 10 to 14 men can effectively handle the work, including the mixing, pouring, cutting and handling. All bar bending is done in this building also. The plan of operation is to use five days of the week for making the beams, leaving the sixth day for cleaning the beds. The same building is used for making concrete fence posts used throughout the farm area.

The storage yard, located alongside the factory, has provision for retaining a stock of completed beams until required for installation. Two gantry cranes of five tons capacity each handle the beams. In some cases storage has been provided alongside the buildings in which the beams are being installed. A month's curing is given before placing.

Interior of floor beam plant, showing bed on which beams are made, cutting machines, electrically driven chain hoist and skip, and mixer. A space to the right is used for heating sand and bending rods and as storage for collapsible cores

From the storage yard the beams are delivered on flat cars to the building site, where they are hoisted into position and placed by a travelling crane having an 80-foot boom. After placing the beam in position, grouting and surfacing completes the floor.

Merits of Floor Beams

The advantages of this type of floor have been mentioned previously in part. In the matter of design alone, the hollow beam of this type presents merits that the solid concrete floor does not possess. The concrete is placed where it is most effective, that is, at the flanges where the maximum stresses occur. The sides connect the concrete in compression with the steel in tension and assist in taking care of shear stresses. The unnecessary material in the centre is eliminated with a consequent reduction in weight The factory methods insure effective inspection and produce uniformity of manufacture. The ease of erection makes this beam especially applicable and since forms and scaffoldings are unnecessary a large element of the expense is removed. They can be utilized immediately after placing and are instantly available in any weather. Other advantages such as sound and heat insulating properties, ease of surfacing, finishing, and so on, are evident. Spans as long as 20 ft. are frequent.

Plant for sand screening and stone crushing on the left, with floor beam factory on the right. Portion of seasoning yard is shown with complete beams in process of curing. The beams are handled by a gantry crane

Concrete Proportions

In making these beams, a 1:2:4 mix was used by the builders in preference to the 1:3 mix formerly considered standard. Practical tests have shown the 1:2:4 proportion to be suited to the materials available. The result of this has been a 25 per cent. saving in cost over the 1:3 beams. The question of cutting, where stone is used, does not seem to present any difficulties. One point that is worthy of mention is the care which has been taken by the architects and engineers to secure proper design. A large number of tests were carried out in typical beams to substantiate the calculated stresses and verify the sections adopted. Careful computations were made of the bending moment and shear for every case where these beams were used and the reinforcing was selected to suit individual requirements. Not only are tension rods provided, but in larger beams, rods to withstand compression are inserted to increase the safe loading and to counteract the stresses produced by lifting tackle in case the slings are not fastened at the very ends. In this instance, a case analogous to a continuous beam is produced with top flange tension stresses.

Saving in Cost

The saving in cost which this system has effected may be calculated when it is pointed out that $15,000 was saved in one centre alone. On one of the cottage centres with an area of 100,000 square feet, the floor has been laid at a cost of less than 13c per square foot against about 26c per square foot for a tile and concrete floor laid in some of the first buildings.

It might be argued that the cost of the plant would

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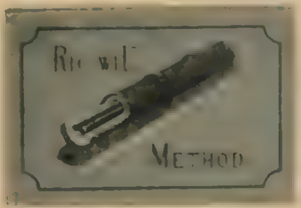

The booklet, "Ric-wil Method" [illegible] interested in the protection of underground steam and hot water pipes. We shall be glad to send it upon request.

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increase the cost of the floor as laid, but it is estimated that an extra charge of 4c per square foot of floor as laid would write off the cost of the plant immediately.

Cement Gun Work

The work on the Whitby hospital is marked by the application of modern and up-to-date methods and one of the most noteworthy of these is the extensive use made of the cement gun. This machine has been used to apply all exterior stucco and interior plaster and when the amount and extent of this work is considered, the value of the cement gun for the application of the material is appreciated. The equipment used at Whitby consists of two guns and two air compressors driven by 50 h.p. electric motors.

In principle, the cement gun consists of two superimposed tanks in the top one of which are dumped the dry materials constituting the mortar. From the bottom one the dry mixture is ejected by compressed air through a hose line with a nozzle at the end. To this nozzle a second and smaller hose delivers a supply of water under pressure which is applied to the dry constituents just before they emerge from the nozzle. The mortar issues from the hose in the form of a spray with considerable force and impinges on the surface to be plastered. The high pressure with which the mortar is applied produces an adhesion and strength that cannot be equalled by hand-applied materials. For rapidity the cement gun is ideal, and where there is so much stucco work as at Whitby its use is almost indispensible. The cost of this portion of the project has been kept remarkably low, due to the cement gun, and yet the product is of a high quality. The adhesion which gunite possesses makes its application possible on fairly smooth surfaces, such as tile, floor beams, steel sections, etc., without the use of lath.

Placing stucco on exterior walls with cement guns. Shows use of swing scaffold for cement gun operations

Waterproof Coatings Used at First

In plastering both inside and outside walls, the mortar has been shot directly on the tile or brick surfaces. At first the difference in porosity between the tiles and joints affected the drying of the plaster and left the joint lines visible. To overcome this, dampproofing paints have latterly been applied to the wall surfaces. It has been found, however, that after a sufficient time was allowed for the plaster on the first buildings to completely dry out the appearance of unequal drying disappeared, so that on work to be carried out hereafter, it has been decided that no such painted coatings will be necessary, except on outside walls.

The plaster is composed of a mixture of five parts of sand to one part of a 1:3 mix of cement and alca lime. The alca lime produced at the Ontario Reformatory, Guelph, contains 85 per cent. hydrated lime and 15 per cent. alca. The mixing of the plaster materials is carried out in a specially equipped building where everything is automatic. This has been done to obviate any errors that are liable to occur with hand proportioning. The mixture is thus of an assuredly constant quality and is not subject to the variation of guesswork.

Setting floor beams on an upper storey with a travelling derrick. These beams are also used for stair construction. Note typical hollow tile wall construction with brick base facing and poured concrete window lintels

The mixing building is located adjacent to the screen house. Two floors are provided, on each of which is an automatic mixing machine. To allow the dinkey to draw materials directly to the upper floor a trestle has been built so that there will be no double handling.

Automatic Proportioning Machines

The mixer machine consists of two hoppers in the bottom of which are worms driven from a single shaft by gearing that is adjusted in such a way as to rotate the gears at relative speeds in proportion to the mix desired. For example, in the upper machine, the lime is placed in one hopper and cement in the other. The worm in the first rotates at three times the speed of the other so that the resulting product contains 3 parts of lime to 1 of cement. This mixture drops to one hopper of the lower machine and is mixed with sand in the proportion of 1 to 5, one worm in this case rotating five times faster than the other. Electric control is adopted and the two machines are kept separate since the upper one supplies material faster than the lower one can consume it, which means that the upper one cannot operate continuously. The mixed material is transported in bags to the gun.

In the operation of the gun, one man supplies the

The Whitby Hospital

One of the cottages after operation with the cement gun.

A Cement Gun Job

The Cement Gun is the most versatile of all construction apparatus. It can be used for finishing interior and exterior walls, waterproofing concrete walls and reservoirs, fireproofing steel, lining tanks, repairing concrete, etc.

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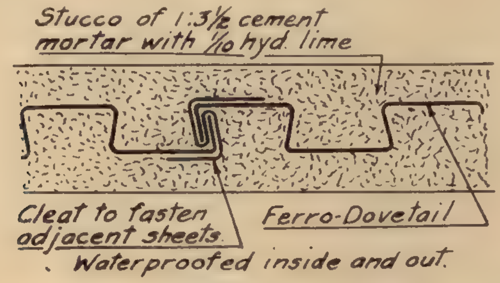
ingredients, one operates the air supply, while one gun manipulator and a finisher look after the plaster. The plaster is float-finished. Any large stones that happen to be in the sand are eliminated, since the impact is not sufficient to impinge them on the wall, and they drop to the floor.

Special Wall for Power House

In connection with the power house, a special form of wall was developed, comprising a ferro-dovetail base with 1½ in. of plaster inside and out. This was also applied with the cement gun. To prevent any possible corrosion from a high lime plaster, the mortar in this case consists of 1 part of cement to 3½ parts of sand with one-tenth hydrated lime.


Stucco of 1:3½ cement mortar with 1/10 hyd. lime
Cleat to fasten adjacent sheets
Ferro-Dovetail
Waterproofed inside and out

Section of power house wall showing ferro-dovetail base, stuccoed both sides.

Sewage Collection and Disposal

The entire group of hospital buildings is served by a complete sewerage system and disposal works. The treatment plant is already completed and the sewers have been laid for two cottage centres. Two systems of sewers, all of tile, are installed, one taking care of sanitary sewage and the other looking after storm water. The latter is discharged directly into the lake, since there is no putrefying matter. The sanitary sewage is treated to render it inoffensive and harmless before allowing it to enter the lake.

Two Drainage Levels

There are two drainage levels on the site, and this has necessitated a collecting tank and pump on the lower level to force the sewage to the treatment plant located in the upper level. This collecting tank or ejector tank is located at the lowest point of the site and is equipped with a submerged centrifugal pump electrically operated and automatically controlled by a float so that it is put in operation only when the sewage reaches a predetermined level. Until this height is reached, the pump is inoperative. From the ejector tank the sewage is pumped to the treatment plant for purification. As the sedimentation tank is located at the lowest point of the upper level, all sewage from this level can flow by gravity directly to the sedimentation tank without being intercepted by the ejector tank, and this eliminates any pumping equipment.

Sedimentation Tank with Syphon Chamber

The purification system includes a tank for sedimentation, with contact beds for bacterial treatment by filtration and provision for chlorination should this be necessary in any emergency. The sedimentation tank is built of concrete on the well-known double-storey principle with a syphon chamber of 1,000 gals. capacity in connection with the main tank. This chamber controls the outflow of the effluent and operates by the pressure head on an inverted syphon. The syphon arm located in the tank terminates in a bell which retains air under pressure from the surrounding liquid and which prevents its flow by exerting a downward force. When a head of 19 inches is reached the air is compressed to such an extent as to allow the liquor to trickle into the syphon pipe. An 8-inch outlet from this tank carries the effluent to the contact beds for filtration and bacterial removal.

Contact Beds

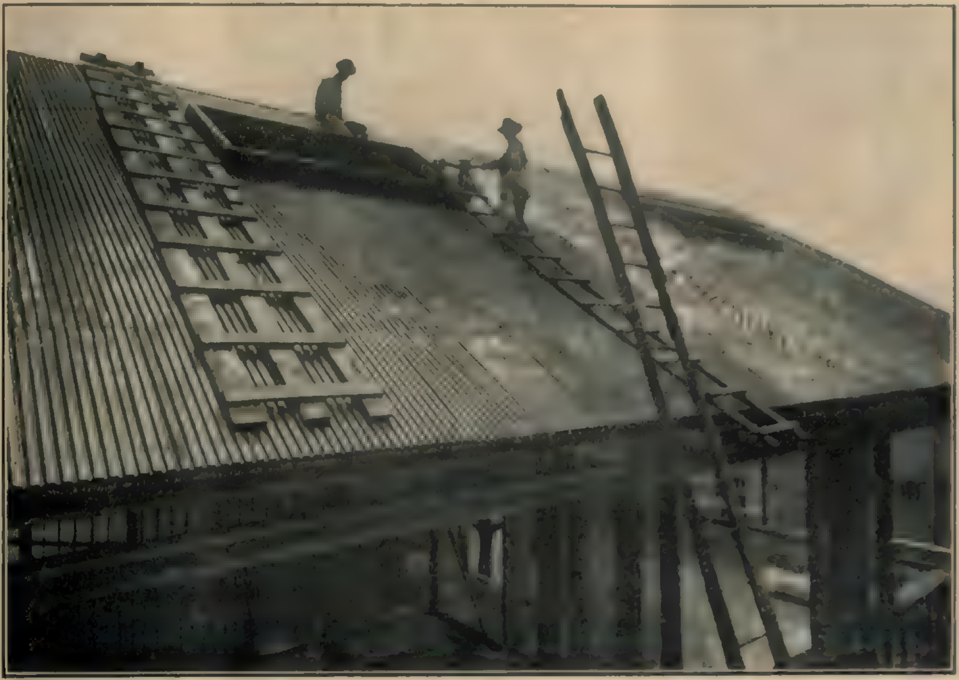
These beds provide for rapid filtration of the liquid through crushed stone. The effluent is applied to the beds by spray-nozzles of which there are 48 altogether. The beds are thoroughly underdrained, and to ensure the greatest possible state of purification, the liquor from the beds can be finally sterilized with chlorine to destroy any remaining disease-producing bacteria. With this treatment the sterilization is sufficient to allow the liquid to be discharged into the lake.

Provision is also made for storing the sewage to allow its use for fertilization purposes. It happens that the land has a gentle lay toward the lake and in dry seasons the sewage may be pumped to a trench to be constructed at the highest line, whence it may flow by gravity over the soil for irrigation and fertilization purposes.

Hollow concrete beams ready for grouting and finishing, as used for fireproof ceilings and flat roofs. Wood roof of mill construction on another building in background

Heat, Light and Power

For a group of hospital buildings such as at Whitby, one central heating plant seems to be the only acceptable plan, with the building located as far as practicable from the main institution without producing undue heat losses. This scheme has been followed out at Whitby and a central power plant provides heat for the entire hospital and may later supply light in addition. The building has been made of sufficient size to accommodate any additional equipment that an extension of the project may require. Future requirements in this regard have been carefully studied and



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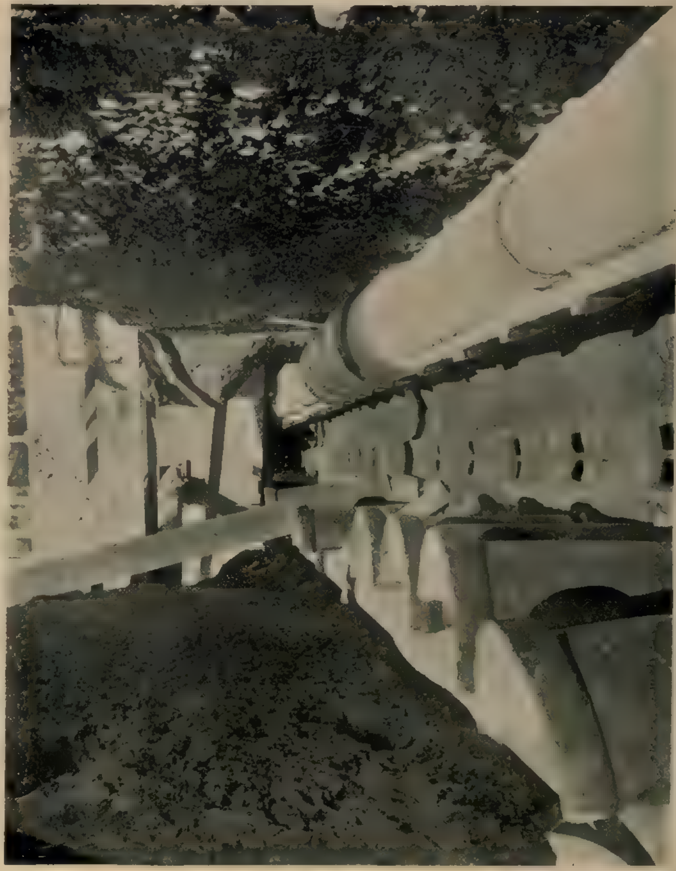
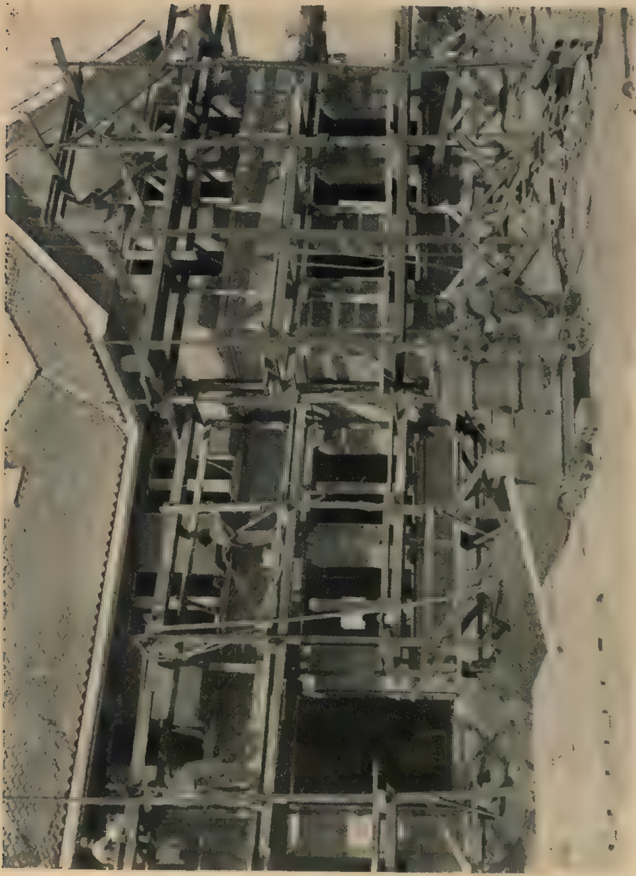
The power house under construction, showing structural steel skeleton on concrete foundations. Reinforced concrete stack being erected at the rear. Coal bunkers are shown in place in the boiler room.



Heating mains enclosed in insulated conduits which rest on a tile base drain shown in the centre

Slopiing roofs are covered with tile made at Government clay plant, Mimico



Placing stucco on exterior walls by means of cement gun. Plaster for interior walls was put on in a similar manner

WATEROUS

Coal & Ash Handling Equipment

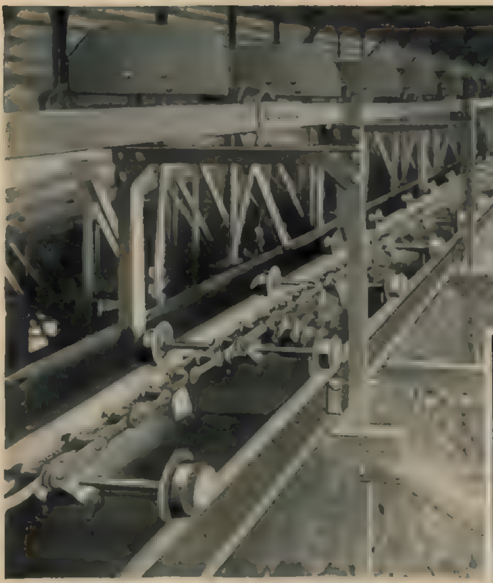
For handling coal in the power house—in and out of storage and to the coal chutes—and for the cheap, efficient disposal of ashes, Waterous Steel Bucket Conveyors are second to none.

These Conveyors are made in various types to suit different installations and are built in sizes to suit every requirement.

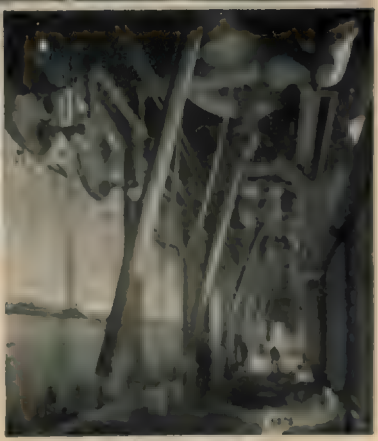
Let us figure on an installation that will save money in your power plant.

If you require steel buckets, steel bins, stoker spouts or coal hoppers, we can build what you want at a reasonable price.

Steel Overhead Bin, supplied by carrier with stoker spout to furnace.



Roller Flight Conveyor, 144' centers, delivering coal to bunkers.



Coal Chutes to boiler room

The Waterous Engine Works Co., Limited, Brantford, Canada

there is every provision for the anticipated growth of the institution.

The type of construction employed in the erection of the power house has already been mentioned, the principal feature being a steel skeleton with plastered ferro-dovetail walls. The mechanical equipment embraces everything needful for efficient and economical operation, with ample provision for future extension.

Boiler Equipment

The boiler equipment consists of four Canadian made water-tube boilers of 350 boiler horse power each, B. & W. type, equipped with Murphy automatic stokers, having 63 square feet of grate surface apiece. The boilers are erected in settings of fire brick with outside walls nine inches thick and lagged with 2-inch magnesia blocks, the whole enclosed in steel. Installation of four more boilers will begin shortly. A brick breeching effectively lagged leads to a reinforced stack 106 ft. high and 8 ft. inside diameter. A steam pressure of 150 lbs. per square inch is carried.

The feed water is supplied to the boilers by double acting, single-cylinder feed water pumps in duplicate and is pre-heated by a Cochrane open feed-water heater provided with a V-notch meter and recorder to permit measurements. Arrangements have been made to permit the installation of forced draft, economizers and superheaters.

Coal Handling

The coal is delivered by railroad cars to a siding alongside the plant. The coal is received in a track hopper and conveyed by a horizontal drag conveyor to a bucket conveyor which lifts the coal to the overhead bunkers above the boilers. This same conveyor is used to remove the ashes and discharge them into an outside chute. The coal, before being chuted to the stokers, is weighed in a travelling weigh bin located just below the bunkers.

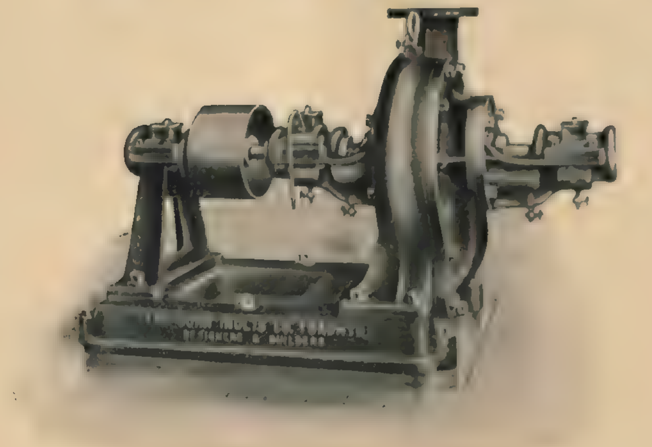
Forced Hot Water Heating

Heating is by forced hot water. The heaters and pumps are located in the engine room. The circulating water is heated by one high pressure and one low pressure heater, using steam. The circulation is forced by two units each comprising an Inglis centrifugal pump with 12-inch suction and discharge and a capacity of 2,750 gallons per minute. Each pump is direct connected to a 125 h.p. Goldie-McCulloch steam turbine operating at 1,500 r.p.m. The heaters may be operated in parallel or in series, the piping and valves being arranged to facilitate this. Space has been left for an additional pump unit and another heater set. The temperature of the heating water is very effectively controlled by operating the return valves so as to cause the return water to back up and decrease the steam space.

The hot water and steam mains are underground and encased in sectional tile conduit with special composition insulation moulded to the pipe. The conduits rest on a hollow tile base drain built on a concrete base. To carry the main in the conduits and to provide for the expansion, rollers are used. The buildings

Power House at Whitby Hospital. This building has a structural steel frame with special walls of ferro-dovetail plastered inside and out with cement mortar. Reinforced concrete stack, 106 feet high, at back. Note ample provision for light.

PUMPS



Horizontal Belt Driven Turbine Pump supplied the University of Toronto.

This Pump is hydraulically balanced against end thrust and in addition has a water cooled thrust Bearing. The Pump is arranged so that it may be operated with guide vanes or without for demonstration purposes. Oil rings, Hydraulic Balance and water cooled thrust bearings are standard for all "Inglis" Turbine Pumps. We make pumps of all kinds for any service.

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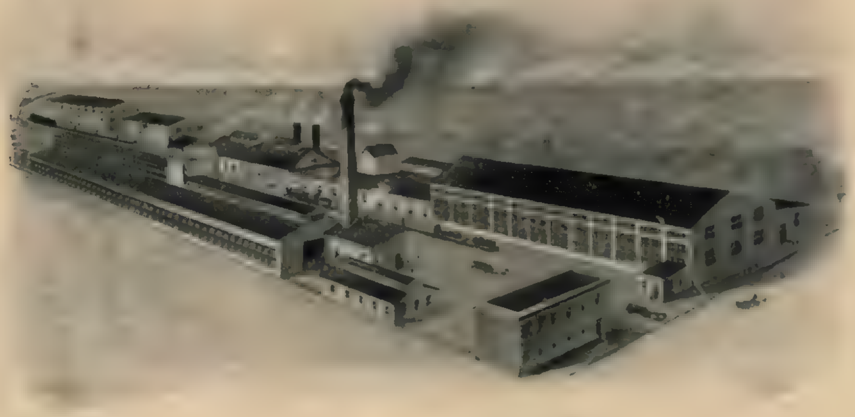


Plant of John Inglis Co., Limited, Toronto

The John Inglis Company, Limited

ENGINEERS AND BOILERMAKERS
14 Strachan Ave., Toronto, Canada
Ottawa Representative:—J. W. ANDERSON, 7 Bank Street Chambers

are heated through the medium of ordinary radiators.

The cottages have mechanical ventilation systems with fans located in the basement with vento-stacks and ducts.

Ice Storage and Refrigeration

An ice storage house of 1,500 tons capacity affords ample space for storage. The ice is obtained from Whitby bay. Two automatic gigs are provided in the storage house for filling purposes. The walls, floors, and ceiling are carefully insulated so that sawdust is unnecessary to prevent melting.

The Cooper brine system of refrigeration has been adopted for the cold storage rooms throughout the institution. By this method, brine is circulated by gravity, using crushed ice and salt as a cooling medium. Surplus moisture in the cold storage rooms is taken up by the use of calcium chloride.

Planning and Organization

One of the most remarkable features of the Whitby Insane Hospital is the care and thought which has been used in planning every last detail. No item, however insignificant it may appear to the casual observer, has, apparently, been neglected. This seems particularly true of the appointments and equipment. However, in matters of construction, the same care in planning and the same foresight is no less noticeable.

Empirical Designs Eliminated

In designing the buildings and equipment incidental to their construction, nothing was taken for granted and empirical designs were eliminated as far as possible. Just as an example, a trestle was built to enable cars to reach the upper floor of the stucco-mixing building already referred to. This trestle was not constructed as is usually done, of timbers which are selected because they look to be of proper size. To be certain of making it sufficiently strong, and to eliminate the chance of waste material, the axle loads of a loaded dump car were actually determined and, using this data, the sizes of the ties and bents were calculated.

In regard to the concrete beams, too, the sizes, as well as the amount of reinforcing, were carefully determined and the calculations borne out by exhaustive practical tests of typical beams loaded to failure. In this way, the correctness of the mathematical determinations was assured. The proportions of the mix recommended for the beams by the proprietors of the patents were tested and after a large number of experiments a different proportion was employed which was found more suitable for the materials at hand and which resulted, as has been indicated, in a direct saving of 25 per cent. in cost.

The Value of Government Organization

Another feature that has been repeatedly pointed out in the foregoing descriptions has been the manufacture by the provincial organization itself of a vast amount of the materials used and also the effective employment of labor under the direct supervision of provincial authorities. The extensive use made of the government clay plant at Mimico and the workshops of the Ontario Reformatory at Guelph, has already been mentioned. Governmental manufacture was not, however, limited to the products of these factories. Even the flat cars used in the industrial railway were assembled at the site of the hospital, the steel framing being bought in the proper sizes and punched ready for assembly. Prison labor was made use of in a great many instances, and the results of their handiwork testify to their skill under proper organization.

Personnel

The design, construction and administration of the Whitby Hospital is under the personal direction of Mr. S. A. Armstrong, Asst. Provincial Secretary. Mr. Jas. Govan is the architect; Mr. Jas. S. Hogg is clerk of works, and Mr. T. L. Rowe is superintendent of construction. Messrs. MacMullen, Riley and Durley (now MacMullen, Riley & Angus), are consulting engineers in regard to the heat, light and power work.

Firms that Supplied Materials and Equipment

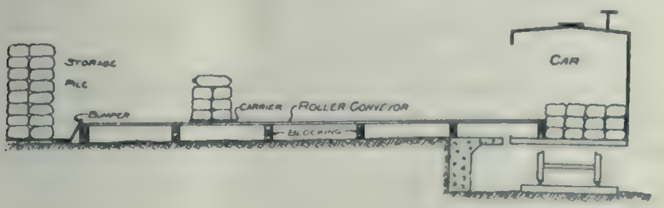
Jenckes Machine Co., blow-off tank; Goldie & McCulloch Co., Ltd., boilers; Bawden Machine Co., Ltd., boiler feed pumps; Robert Simpson Co., Ltd., carpets and rugs; General Concrete Construction Co., concrete chimney; Alfred Collyer & Co., concrete chimney; John T. Hepburn, Ltd., cranes; Canadian Link-Belt Co., Ltd., coal handling apparatus; Canada Cement Co., Ltd., cement; National Portland Cement Co., Ltd., cement; McDonald & Willson Ltd., electric fixtures; Geo. J. Beattie, electric fixtures; Electrical Fittings Co., Ltd., electrical fittings; Northern Electric Co., Ltd., electrical distribution systems; Steel & Radiation Ltd., expanded metal; A. B. Ormsby Co., Ltd., fire doors; W. E. Dillon Co., Ltd., fire doors; Dunlop Tire & Rubber Goods Co., Ltd., fire hose; Canadian Griscom-Russell Co., Ltd., feed water heaters; Taylor-Forbes Co., Ltd., fittings; Pedlar People Ltd., ferro dovetail; R. Bigley Mfg. Co., Ltd., cast iron fittings; Pilkington Bros. Ltd., glass; Consolidated Plate Glass Co., Ltd., glass; Roelofson Elevator Works Ltd., hoists and dumb waiters; Belleville Hardware Co., Ltd., hardware; Johnston Temperature Regulator Co., temperature regulators; C. A. Dunham Company, Limited, heating system; Gurney Foundry Company, Limited, kitchen equipment; Galt Art Metal Co., Ltd., metal lath; Martin Senour Co., Ltd., "Concre-Tone" for walls; Garlock Packing Co., Ltd., packing; Fred. Armstrong Co., Ltd., plumbing; Page Hersey Co., Ltd., pipe; Ric-wiL Underground Pipe Covering Co., pipe covering; Armstrong Cork Co., Ltd., pipe covering; Canadian H. W. Johns-Manville Co., Ltd., pipe covering; Philip Carey Mfg. Co., pipe covering; John Inglis Co., Ltd., power plant equipment; Smart Turner Machine Co., Ltd., pumps; Storey Pump & Equipment Co., pumps; John Hillock & Co., Ltd., refrigerators; Robinson Bros. Cork Co., Ltd., refrigeration insulation; Madison Cooper Co., cold storage system; Baines & Peckover, reinforcements; Hamilton Bridge Co., Ltd., structural steel; Dominion Bridge Co., Ltd., structural steel; C. W. Beal, wall tile; Canadian Sirocco Co., Ltd., ventilating equipment; Canadian Buffalo Forge Co., Ltd., ventilating equipment; Pacific Flush Tank Co., sewage flush tanks; James Langmuir & Co., Ltd., shingle stains; London Concrete Machinery Co., Ltd., concrete mixers and brick making machines; Mussens Ltd., "Smith" mixers; F. H. Hopkins & Co., concrete mixers; Ransome Concrete Machinery Co., concrete mixers; Davenport Locomotive Works, contractors' locomotives; Canadian General Electric Co., Ltd., water feed heaters; Murphy Iron Works, stokers; Bishopric Wall Board Co., Ltd., wall board; Mastic Wall Board & Roofing Co., stucco plaster board; Canadian Siegwart Beam Co., Ltd., Siegwart beams; Cement Gun Co., cement guns; Canadian Asbestos Co., Ltd., pipe covering.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Gravity Conveyors for Handling Concrete

The use of gravity conveyors for unloading such building materials as tile, concrete block, brick, etc., is well known to contractors and material men. The conveyors are exceedingly simple, consisting of substantial guide rails between which rollers on ball bearings are placed at close intervals. The rollers revolve very easily, and a slight grade allows the transfer of the load. The use of gravity conveyors for handling cement is less common, but they are now being used quite frequently for unloading purposes, and the illustrations reproduced herewith, taken from "Concrete," show two ways in which contractors have made use of gravity conveyors for handling cement.



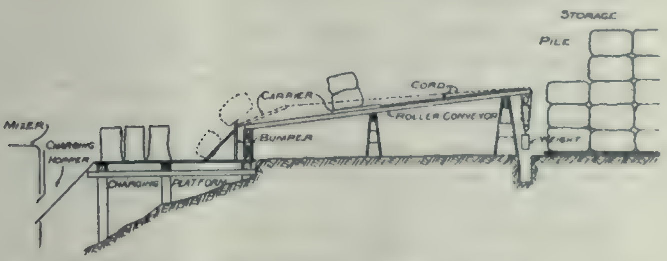


Fig. 1. Unloading cement from cars on a gravity conveyor.

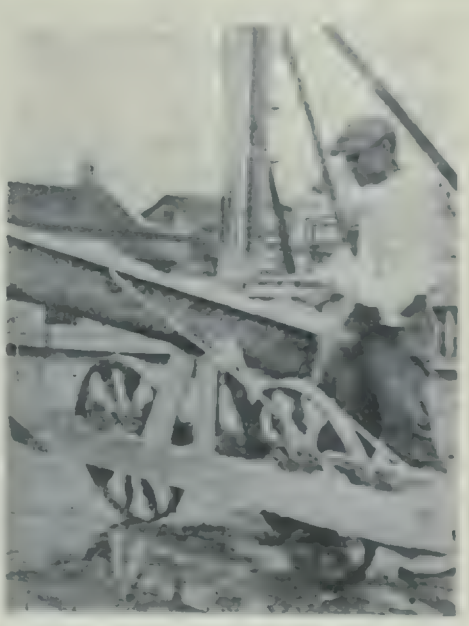
Fig. 2. Moving cement from storage pile to mixer, showing automatic return of carrier.

Fig. 1 shows the unloading of cars on an actual job. Cement was carried from 40 ft. to 75 ft., and the total slope was but a few inches, the operator giving the loaded carrier a push to send it the entire distance. The bags were placed on wood pallets or carriers, several of which were used and which were returned by a laborer. One end of the conveyor ran well into the car door and was raised about 18 inches from the floor, while the storage end was also raised to avoid lifting the cement from the ground level. About eight bags were loaded on the carrier at a time and 800 bags could be unloaded, moved 50 feet, and piled in 32 labor hours.

In Fig. 2 is shown a scheme for moving cement from the storage pile to the mixer. This method was also used in actual work. The conveyor had a good slope and was comparatively short. At the lower end of the conveyor a bumper was built that would just catch the carrier. A single carrier was used, loaded with two bags at a trip. By means of a cord fastened to the carrier and running back beside the conveyor and connected with a weight the carrier was automatically returned. When the load was placed on the carrier a holding catch was automatically released and the load rolled to the other end of the line, where it struck the bumper and automatically dumped the cement, which slid to the feet of the man who was charging the mixer. On being relieved of the weight of the cement, the weight on the cord instantly brought the carrier back to the man on the storage pile. By this arrangement but one man was needed for handling the cement.

A Home-Made Rig for Wheeling a Concrete Chute

The illustration herewith portrays a novel, but handy, rig described by a writer in Engineering Record. This appliance, christened a "bicycle," can be made in less than an hour out of a pair of wheels from an old concrete buggy and a few planks and reinforcing rods, and is used to ride the end of a concrete chute around the area of a building being poured. As will be observed, the "boxes" of this vehicle are carefully covered with pieces of plank to prevent them from being filled with grout. The machine saves a great deal of labor over the ordinary practice of using small wooden horses, as anyone can appreciate who has watched four or five "hunkies," ankle deep in concrete, clustered around the end of such a chute in an effort to raise and carry it to a new position. It is so easy to move the chute with the rig that the concrete can be put directly in place with little trouble, and the shoveling required is considerably reduced.



A handy device for carrying the end of a concrete chute.

There are now 92 cities in the United States with the manager form of government.

Oil Possibilities in New Brunswick

New Brunswick undoubtedly possesses a valuable asset in its oil shales deposits near St. John. One of the best English authorities on oil—Sir Boverton Redwood—who made an exhaustive survey of this deposit two years ago, reported that the New Brunswick shale was capable of producing 33 imperial gallons of crude oil per ton of shale and 60 pounds of sulphate of ammonia. It is estimated that a plant with a capacity of 1,500 long tons per day can retort 547,500 tons per annum, equalling 18,000,000 imperial gallons of crude oil and 13,687 tons of sulphate of ammonia. The oil may be divided up as follows: Gasoline, 2,137,500 gallons; illuminating oil, 7,951,500 gals.; lubricating oil, 2,565,000 gals.; fuel oil, 1,710,000 gals.; paraffine wax, 6,120,000 pounds; coke, 1,530 tons. This distillation estimate is based upon the old method. By some of the newer methods it is claimed that New Brunswick shale oil will produce more than three times the above quantity of gasoline per ton. It is believed that there is already sufficient shale available to operate for fifty years at least five plants of the capacity of the one above proposed. The New Brunswick shale is said to be of much better quality than the shale of Colorado, and the quantity is greater. The geological authorities at Washington, recognizing this fact, have been devoting considerable attention to the New Brunswick deposit. Increased development in connection with these deposits is looked for within the next few months.

Military Engineering Described to the Calgary Branch, C. S. C. E.

The Calgary branch of the Canadian Society of Civil Engineers held its regular monthly meeting on December 20, 1916, when Captain H. Sidenius, headquarters staff officer of Military District No. 13, spoke on "Military Engineering and Trench Warfare in the European War." Captain Sidenius gave a general description of the organization of trench warfare, and by means of blackboard sketches illustrated the means of building the various kinds of trenches necessary in the present war. He also described the construction of obstacles, wire entanglements, machine gun emplacements, and telephone connections, as well as the details of organization of trench defence and attack. In connection with maps prepared from aircraft observation, which he exhibited, he pointed out one feature which illustrates the marvellous efficiency of the military organization at the front; that is that the results of aircraft observations made in the forenoon are issued in the afternoon of the same day, complete with finished maps, which show the exact location of the enemy trenches, as well as natural or artificial topographical features.

It might incidentally be mentioned that over 30 per cent. of the members of the Calgary branch have already gone to the front, and that it is the intention of the society to unveil a roll of honor at an early date.

The Weber Chimney Company, a firm specializing on the construction of reinforced concrete chimneys, has written to the Portland Cement Association as follows: "We are at the present time building the highest chimney in the world, in Japan, for a copper smelter. This chimney is 567 feet high and 26 feet 5 inches inside diameter at the top. It is more than 60 feet higher than any chimney ever built of any type of construction for any purpose."

Mainly Constructional

East and West—From Coast to Coast

It is stated that 600 carpenters are wanted to go to Europe from Canada to build a huge munition plant.

The building permits issued in Galt, Ont., for 1916 total $253,795. This is an increase over the previous year of $113,646.

The Robinet Brick Company, Limited, a company incorporated under the Ontario Companies Act, has been dissolved.

The Aetna Iron and Steel Company, Limited, has been incorporated, with a capital of $250,000; head office at Victoria, B.C.

The Dominion Iron and Wrecking Company, Limited, has been incorporated, with a capital stock of $50,000; head office at Montreal.

La Compagnie de Construction de Laval de Montreal, Limitee, has been incorporated, with a capital of $99,000; headquarters at Laval de Montreal.

Francis Hankin & Co., Limited, has been incorporated, with a capital stock of $45,000; headquarters at Montreal. The firm will handle building supplies.

Brant County is the twenty-fourth county to adopt the good roads system under the Ontario Highways Act. It is proposed to improve 100 miles of rooads.

The total number of building permits issued during the year 1916 in St. Catharines, Ont., was 647, the value being $596,715. This compares with 646 in 1915, value $442,384.

Halifax has had a record building year. The value of the permits issued amounts to $1,250,000, an increase of $160,524 over 1915. The value of permits from 1912 to date totals over three million dollars.

Connell's Bridge, crossing the stream between Torbay proper and Tapper's Cove, Newfoundland, has been replaced by a structure of concrete. The new bridge has a total length of 24 ft. 6 in., is 11 ft. high, and 16 ft. in width.

The value of the building permits issued in Welland, Ont., for the month of December, 1916, amounted to $11,225, as compared with $19,635 for the same month in 1915. The total for 1916 was $202,587, as against $191,232.60 the previous year.

McMillan Brothers, Limited, has been incorporated, with a capital stock of one million dollars, head office at Winnipeg. The firm will carry on the business of builders and contractors, and will take over the business of "McMillan Brothers, Railway Contractors."

Building permits numbering 76 and valued at $299,200 were issued in the month of December, 1916, in Montreal, as compared with 104 in 1915, at a value of $2,044,425. The total for the year 1916 is 1,880 permits, valued at $5,934,184, while during 1915 there were 2,081 permits issued, value $8,511,221.

There were 31 building permits, valued at $18,705, issued in the city of London, Ont., in the month of December, 1916, as compared with 24, valued at $24,270, in December, 1915. During the year 1916 the total number of permits issued was 1,034, value $926,125. This compares with 1,235 in 1915, value $1,207,630.

Orders have recently been issued authorizing the changing of the 228th Battalion from an infantry into a railway construction unit. This will necessitate the reorganization of the staff, as only officers with qualification as engineers can hold commissions with railway construction units. Lieut.-Col. Erchman, the commanding officer, and a number of his officers are engineers by profession. The 228th was recruited in the Sudbury and Nipissing districts, and is composed largely of railway men, miners, and woodmen.

Vancouver's building permits for the month of December, 1916, numbered 29, and are valued at $286,365. In the corresponding month in 1915 an equal number of permits was issued, but the value was only $27,180. The total for the twelve months of 1916 is 413, value $2,412,889, as compared with 612, value $1,593,229, in 1915.

Engineer Thompson, of the Valley Railway, reports that about ten miles of rails will be laid to Queenston on the new line this winter, leaving thirty miles still to be railed between that point and Westfield. The scarcity of labor and the demand for rails on the other side of the Atlantic have tended to delay the progress of the road.

Application has been made for a Dominion charter by the Northern Bolt, Screw and Wire Company, Ltd. This new company has been formed to take over the business of the Northern Bolt and Screw Company, whose business had expanded to such an extent as to require further capitalization. The capital of the new firm has been increased from $200,000 to $500,000.

Mr. W. W. Van Every, manager of the Water and Light Department of Sault Ste. Marie, Ont., has submitted estimated figures on the construction cost of a water supply system for the city, first taking the supply from Coldwater Creek, and, second, taking the supply from St. Mary's River at Old Vessels Point. These are as follows: First, total construction cost, $362,000; operating costs, approximately $21,000; second, total construction cost, $478,000; operating costs, approximately $25,000.

The test of the wells at the Sarnia waterworks, Point Edward, is still under way, and the present flow averages about 500,000 gallons per day, according to the officials of the fire and water committee. The inspector of the Fire Underwriters' Association, however, states that in order to maintain the present rating of fire insurance the city must have a supply of at least six million gallons per day. It is stated that of the three new wells the one nearest the lake produces the largest flow of water. It may, perhaps, be necessary to sink more wells along the shore until a sufficient supply is obtained to meet the demands of the city.

Engineer A. L. McCulloch, who has been making an investigation of additional possible water supply for Trail, B.C., recently made a preliminary report to the city council. Several contiguous creeks were investigated, of which the measured flow was found to be as follows in gallons daily: Cambridge Creek, 630,000; Nigger Creek, 260,000; Gorge Creek (present supply), 118,000; Ryan Creek, 180,000; Tiger Creek, 115,000. The present flow, it is anticipated, will be reduced by about one-third at extreme low water. Mr. McCulloch's recommendation is that the city utilize Cambridge Creek, together with Violin Lake, for storage purposes, to supplement the flow. Cambridge Creek has a watershed of 4½ square miles and is fed with springs. It is hoped, in this way, to secure a minimum of 1,000,000 gallons per day. There is a height of 23 feet between the source of Cambridge Creek and Violin Lake, and a total distance of 2,700 feet. Violin Lake can be utilized by a dam or a syphon, the latter being the most feasible.

The report of the Works Committee of St. Catharines, Ont., for the year 1916 mentions that the greatest saving effected was in the street cleaning department. The method of financing street watering as it applied to paved streets was changed, being amalgamated with the street cleaning department. It is stated that this has resulted not only in a saving of money, but in a much more satisfactory service. Watering was eliminated entirely from residential streets and machine sweeping substituted. The down-town streets were cleaned by patrols, sweeping machines, and flushing wagons, and sprinkling was only resorted to as a dust layer on the main business streets. The dirt streets generally were oiled with 40 per cent. asphaltic road oil. The total cost for the year of street sprinkling and flushing has been $1,314 62, the total cost of the oiling has been $2,080 47, and the total cost of other methods of street cleaning $6,897 28, making a grand total for the combined system of $10,292 37. For the year 1915 the total cost of the same work was $11,433 46.

Personals

Lieut. K. L. Duggan, of the Mounted Rifles, the son of Mr. G. H. Duggan, of Montreal, president of the Canadian Society of Civil Engineers, is reported wounded in action.

Mr. H. G. Barber has been appointed a lieutenant in the 239th Battalion Overseas Railway Construction Corps, Canadian Expeditionary Force. He was formerly resident engineer for the C.P.R. at Nelson, B.C.

Mr. John G. Sullivan, M. Can. Soc. C. E., chief engineer of the Western lines of the Canadian Pacific Railway, has been nominated for president of the American Railway Engineering Association for the coming year.

Mr. Allan George, of George & Moorhouse, architects, Toronto, has received an appointment as lieutenant in the 256th Construction Battalion. His partner, Mr. Walter Moorhouse, has been in the trenches for the past fifteen months with the 8th Machine Gun Battery.

Major Arthur E. Dubuc, commanding the 22nd Battalion, is among the officers mentioned in the New Year's honor list. He received the D.S.O. Before going on active service he was the district engineer in Montreal for the Department of Public Works. He has been twice wounded.

Lieut. H. Featherston, of Montreal, has been awarded the military cross. Prior to the war he was in partnership as architect with Mr. J. McDougall. In England he was transferred to the 1st Battery, 1st Brigade Canadian Field Artillery, and was appointed A.D.C. to General Burstall.

Mr. W. A. Cowan, A. M. Can. Soc. C. E., who was formerly division engineer Transcontinental Division (Ontario), Canadian Government Railways, has been appointed acting general superintendent Transcontinental Division, Cochrane, Ont., during the absence of Mr. F. P. Brady, on account of ill-health.

Mr. A. E. Griffin, of the firm of Foley, Welsh & Stewart, has been asked to report in England at once, where he will be given charge of the corps of railway construction men which is being raised for service in France. Commissions in the new corps, under Lieut.-Col. Griffin, have been offered to Messrs. W. Sharp, C. Leader, A. McIntosh, and A. Wimbles, all of whom have also been connected intimately with the work of Foley, Welch & Stewart. They have been associated with the 72nd Seaforth Highlanders in Vancouver. The appointments are made by Col. J. W. Stewart, who is so well known in connection with railway construction work, and who now holds the position of deputy director of light railway construction in France.

Lieut.-Col. L. T. Martin, director of the Kennedy Construction Company, Montreal, a member of the firm of O'Brien & Martin, railway contractors, and general manager of the Great Lakes Dredging Company, Port Arthur, has been commissioned to raise a new construction battalion, consisting of 1,200 officers and men, which will be recruited from all parts of Canada. This battalion will be on similar lines to the one raised by Lieut.-Col. Ramsay of the C.P.R., which has done splendid work in the construction of military railways. Lieut.-Col. Martin is associated in business affairs with Mr. M. J. O'Brien, of Renfrew and Montreal, the well-known railway contractor, who is also interested in many and varied industries. His experience in railway construction and organization should prove of immense service to the Allies.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Brantfor,d Ont.
The county council contemplate the construction of 100 miles of roadway. A. E. Watts, K.C., is clerk.

Dartmouth, N. S.
The by-law for the water and sewerage extension on Stair Street and Victoria Road has been passed. It is estimated to cost $5,000. Clerk, Alfred Elliot. Engineer and Acting Superintendent, E. Nichols.

Dundas, Ont.
The by-law regarding the construction of trunk sewers, etc., to cost $55,995, was carried here on January 1st. Messrs. Murray & Lowes, 186 King Street West, Toronto, are the engineers.

Hamilton, Ont.
The by-law for the construction of storm sewers to cost $61,000 was defeated here on January 1st. S. H. Kent is city engineer.

Markham, Ont.
A by-law was carried here to raise $6,000 for the extension to the waterworks system. Clerk, M. White.

St. Lambert, Que.
Tenders will be received by the secretary-treasurer until 5 p.m., January 22nd, for the supply of pumping equipment. H. A. Gibeau, Town Hall, is engineer.

The building of a main highway along the south shore of the St. Lawrence River is contemplated here by the Provincial Government. Minister, L. A. Taschereau, Quebec. Government Engineer, Mr. Lariviere, Quebec.

Sandwich, Ont.
Plans are being prepared for sewer and water mains of vitrified, salt glazed construction to be laid here. C. R. McColl, 125 Assumption Street, Windsor, Ont., is engineer.

Plans and estimates are being prepared for cement and concrete pavement and walks to be laid on Askin Boulevard here. C. R. McColl, 125 Assumption Street, Windsor, Ont., is engineer. Work will commence in the spring.

Sault Ste. Marie, Ont.
By-laws have been carried for the construction of storm sewers on McGregor Avenue, $30,000, and on Elgin Street, $18,000. R. G. Campbell is clerk.

Toronto, Ont.
The Secretary of the Board of Control, T. McQueen, will receive tenders until January 16th for excavating, laying and jointing of 12-inch water pipes, valves and special castings. Specifications, etc., may be seen at room 320, City Hall.

Trail, B.C.
In connection with the water supply and sewage system for this city, the engineer, A. L. McCulloch, Nelson, B.C., recommended that the city utilize Cambridge Creek, together with Violin Lake, to supplement the flow for storage purposes, Violin Lake to be utilized by a dam or a syphon, the latter being probable. Engineer is now taking levels for sewer system, to be built on the local improvement plan.

CONTRACTS AWARDED

Winnipeg, Man.
The London Concrete Machinery Company have secured the contract to supply the Winnipeg Aqueduct Construction Company with three one-yard batch mixers.

In connection with the construction of 9½ miles of reinforced concrete pipe for the Greater Winnipeg Water District, the general contract has been awarded to Winnipeg Aqueduct Construction Company, 617 Union Bank Building. Work will be started in the spring. Contract covers the supply of pipe and labor of laying same.

Railroads, Bridges and Wharves

Banff, Alta.
The Cascade Scenic Railway Company contemplate the building of a scenic railway at this place. Solicitors, Moran, Anderson & Guy, of Winnipeg.

New Westminster, B.C.
Plans are being prepared for a new freight shed to be erected here for the Northern Pacific Railway. F. G. Prest, St. Paul, Minn., is purchasing agent.

Peace River Crossing, Alta.
Tenders are to be called by the Edmonton, Dunvegan and B. C. Railway for the erection of a bridge of steel construction over the Peace River. Engineer, W. R. Smith, Edmonton, Dunvegan & B. C. Station. Approximate cost, $1,000,000.

Victoria, B.C.
A by-law is to be submitted on January 11th to raise $40,000 for the construction of a steel bascule swing or lift bridge. W. J. Dowler is clerk.

Wiarton, Ont.
The Keppel Township Council contemplate the construction of a bridge. Clerk, G. W. Atkey, Wiarton. Approximate cost, $3,500.

CONTRACTS AWARDED

St. Andrews, N.B.
Barrott, Blackader & Webster, 10 Cathcart Street, Montreal, are the architects on the dormitory to be erected here for the Canadian Pacific Railway. The general contractors are the Deakin Construction Company, 37 Mayor Street, Montreal. Building will be three storeys and of stucco construction.

Public Buildings, Churches and Schools

Causapscal, Que.
The erection of a school, to cost $3,000, is contemplated here. H. Lemarié is secretary-treasurer of the School Board.

Dundas, Ont.
The by-law for the erection of a high school here was defeated on January 1st. W. H. Moss is Secretary of the Board of Education.

Esquimalt, B.C.
The erection of an eight roomed school is contemplated here. L. Tait, Capt. Mulcahy and W. Walker Wilson are members of the Building Commission.

Fraserville, Que.
An addition to the Hospital St. Joseph Du Precieux-Sang is contemplated here. Superior, Sister M. Olympiade.

Halifax, N.S.
The Military Hospitals Commission, Cogswell Street, contemplate converting the old Dalhousie College building into a convalescent hospital. Two additional wooden wings will be erected.

Listowel, Ont.
A by-law was passed here for improvements to public and high schools at a cost of $20,000.

Montreal East, Que.
Plans are in progress for the erection of a school for the Roman Catholic School Commission, 5430 Notre Dame Street East, to cost $25,000. O. Lamonche is secretary-treasurer.

Niagara Falls, Ont.
A new fire hall of two storeys and brick construction to cost $12,000 is contemplated here. W. J. Seymour is clerk. By-law was passed on January 1st.

Owen Sound, Ont.
School Section No. 1, Sarawak and Keppel Townships, contemplate building a new school house early in the spring. Secretary-Treasurer, Wm. Cavell, R. R. No. 7, Owen Sound.

Repentigny les Bains, Que.
The erection of a school, to cost $4,000, is contemplated here. Ludger Hervieux is secretary-treasurer.

Rigaud Village, Que.
The erection of a school, to cost $10,000, is contemplated here. J. F. Chevrette is secretary-treasurer.

Riviere Bleue, Que.
The erection of a school, to cost $7,000, is contemplated here. Joseph Berube is secretary-treasurer.

St. Eusebe, Que.
Tenders will be received until January 15th by J. W. Dionne, Curate of the new church to be erected here at the cost of $15,000.

Sydney, N.S.
Alterations to orphanage building are

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **January 17, 1917** **No. 3**

Principal Contents

Page
Editorial ... 49
Sheet Asphalt Street Pavements ... 51
Reinforced Concrete Ship Construction ... 53
Concrete Roads of Doubtful Economy ... 55
C. S. C. E. Committee Reports ... 56
Union School at Brighton, Ont. ... 60
Building Code for Flat Slabs for What is Known as Four-way Type of Construction ... 61
Practical Hints for the Contractor ... 65
Hydrated Lime Produces Beneficial Results and Overcomes Difficulties ... 66
Mainly Constructional ... 67

Meeting Labor Shortage

THERE has been a considerable amount of discussion recently regarding the employment of alien enemy labor on Canadian construction work, both governmental and private. Patriotic fervor naturally rebels at the thought of such apparent lack of discrimination in war times. Without either advocating or condemning the use of enemy labor without a clearer understanding of the individual circumstances pertaining to each particular job, we believe the fact that such a condition obtains only serves to impress the present labor situation more forcibly upon us. Contractors throughout Canada universally agree that the greatest trouble they are up against is the unprecedented labor scarcity. In all probability this country has never before experienced a shortage of workmen in all lines to as great an extent. In every branch of industry skilled and unskilled labor is increasingly difficult to obtain.

The existing conditions have resulted in higher construction and material costs, in retarded deliveries and delayed progress. These factors have, no doubt, been material influences in curtailing the volume of construction work in Canada during the past year, and in all probability the effect will be more noticeable during the coming building season.

* * *

War conditions are generally responsible for the labor scarcity. The methods of recruiting heretofore adopted have not sufficiently distinguished between men needed at the firing line and those whose abilities **and skill should keep them at home. The ranks of the** skilled artisans have thus been depleted of the foremost of their class, leaving, in most cases, nothing but the most indifferent to fill the vacancies. Although the United States has helped to relieve the scarcity, the demand for labor in that country has necessitated the keeping of almost all classes of men within their own borders. Contractors explain that the apparently open employment of alien enemy labor offers, under these conditions, the only solution for unprecedented difficulties, especially when the buildings are under contract for erection within a stipulated **time limit, as is the case with many of our new munition shops.**

The problem of labor scarcity and resulting high wages brings with it the matter of readjusting conditions to meet, and overcome if possible, the effects imposed by such a shortage. Efforts should be made **to offset the growing seriousness to the construction** business of a failure of labor. Nothing can better help to stimulate the war-ridden spirits of our people than **an effort to improve conditions, and a continuance of** building operations, within reason, of course, seems to offer the best medium for stabilizing the situation **Contractors ought, therefore, to reorganize their facilities for meeting this problem.**

This year's work, to all appearance, will tax the country's labor supply. Increased material costs and the difficulty of deliveries are bound to have a retarding influence on building construction. The only way open for the builders is to conserve their workmen. Present circumstances have produced less efficient labor because it has decreased the supply of skilled labor. Methods must be sought to conserve and improve the efficiency of the working force, to reduce manual labor **to a minimum, to devise schemes that are labor-saving.**

* * *

Labor-saving tools coupled with a more efficient organization seem to offer the desired solution. A **more extensive use of construction plant, with more** copious employment of special methods are highly desirable and there are indications that such are on the increase. Builders should be ready to seize every opportunity to install a device or employ a process that will lead to a conservation of their working force. They should scan the horizon for new economies and improved developments. These necessities are forced on many builders by circumstances, but they should be more vigorously sought at the present moment as a means of raising the standard of efficiency. The business aim of every contractor is to produce the maximum amount of work for the least expenditure and investment. More machines, better plant, more efficient organization will secure this ideal and produce thereby advantages of great benefit and lasting effect.

Toronto's Flat-Slab Building Code

We print elsewhere in this issue a brief article by Mr. W. W. Pearse, C.E., city architect and superintendent of buildings of the city of Toronto, on the subject of four-way flat slab concrete construction. The city of Toronto has not had any standard specification covering this type of construction, and quite recently decided to adopt, temporarily at least, the code of the city of Chicago. Mr. Pearse was naturally anxious to verify the dependability of the Chicago code, which though in force for several years has remained a closed book so far as the theory underlying its original recommendation for adoption is concerned. With the object of discovering this theory he has followed up several synthetic suggestions, and has finally succeeded, apparently, in duplicating the original line of computation followed by the men who compiled the Chicago code. This theory, in Mr. Pearse's opinion, affords an ample factor of safety, and he is now thoroughly satisfied with its adoption for the city of Toronto.

In the same article Mr. Pearse has generously handed us for publication a valuable table of calculated quantities for this type of construction work which will not only be found a very considerable time-saver by the contractor but will also act as a check or guarantee of the accuracy of such figures which any contractor may choose to work out for himself. We particularly commend this table of values to contractors and architects in general, as we know just how great the difficulties have been in the past, caused either through errors in such calculations or entire inability to cope with the problem. We speak of Mr. Pearse's action as generous, as it shows what we consider to be a very proper spirit—all too rare in these days of keen competition—a desire to help the other fellow smooth out some of the rough places on his pathway.

We understand that it is just possible some modification may be allowed from the Chicago code, but this has not yet been determined, and will depend to a considerable extent upon certain exhaustive tests by the city architect's department now under way and nearing completion.

Comparative Bids Show the Cheapness of Concrete Buildings

In connection with the plans of an office building recently erected in Chattanooga, Tenn., a variety of alternative specifications were drawn up for the purpose of obtaining comparative bids on different types of design. The figures that were received are of interest as illustrating the very wide variation in cost that exists for various modes of construction, and they further show that concrete construction is considerably cheaper than a design carried out with steel. The accepted bid for a concrete building was but 52 per cent. of the lowest tender for a standard structural steel frame with terra cotta flat arch floors. The wide discrepancy between the costs of different designs is shown by the fact that the lowest bid for the most expensive type of design was 125 per cent. greater than the smallest tender received.

The building in question is 94 ft. by 135 ft. in plan and 12 storeys high. The foundations were built with reinforced concrete piers to bed rock, and tenders for this portion of the work were not included in those for the superstructure. For the portion of the building above the foundations the specifications were drawn up to invite bids for six different types of design, as follows: (1) structural steel skeleton with terra cotta flat arch floors; (2) structural steel skeleton with reinforced concrete and terra cotta floors; (3) reinforced concrete skeleton with either reinforced concrete and terra cotta or metal floor slabs; (4) structural steel frame with reinforced concrete and metal floor slabs; (5) structural steel-concrete construction, known as "M" system, patented by the Standard Concrete Company; and (6) system used by the Metropolitan Fireproofing Company.

The lowest bids for each design were as follows: (1) $139,000; (2) $138,000; (3) $72,000 for the reinforced concrete frame and terra cotta floors, or $69,000 for metal floor slabs; (4) $127,000; (5) $147,000; and (6) $155,000.

The $72,000 tender was accepted. Preference was given to this figure over the $69,000 bid because it was believed that the use of terra cotta in place of metal floors was worth the difference.

The above figures show the wide range in cost that exists for various types of construction. The remarkable cheapness of concrete is well exemplified, the cost of such a building being roughly one-half that of a structural steel building. Part of this discrepancy is accounted for, no doubt, by the high current prices of steel and uncertainty of delivery, coupled with the relatively low cost of concrete.

An interesting point exhibited in this building is the use made of rich mixes, advantage being taken of the low price of cement. A 1:1:2 mix was adopted for the columns up to the tenth floor, with a 1:1.8:3.7 mix above the tenth floor. Comparatively small percentages of steel were employed.

A Survey of Canada's Natural Resources

A survey of the natural resources of Canada is being undertaken in connection with the Canadian Pacific Railway, which has for its purpose the co-ordination of the work which has been done by government departments, with other data which the government has not collected, thereby making easily accessible, to those qualified to utilize the information, as much data as possible relative to the natural resources of Canada. Care will be taken not to do work that has already been done. Arthur D. Little, Ltd., the Canadian branch of a Boston organization of analytical chemists, are the directors of the work. The information now available is to be collected on standard forms and transferred to cards, so as to make it possible to quickly separate the cards according to required classification at the moment. Thus if one desires to know all the places in Canada where deposits of iron are to be found in proximity with limestone, water power, or some other resource, the list of localities can be supplied very quickly. To accomplish this work it is announced that it will be necessary to have part time assistance from many people who may be able to devote a small fraction of their spare time to the work because of self-interest, patriotism, local pride, and in some cases nominal remuneration. A bulletin is now being compiled setting forth in greater detail the plan and purposes of the survey, and this will be sent out especially to those whose co-operation is desired.

A new field for the use of bitumen in road surfacing was indicated in the discussions at the recent meeting of the American Association of State Highway Officials. This was in connection with the construction of sand-clay, top-soil and gravel roads, such as are being built so extensively throughout the South.

Sheet Asphalt Street Pavements

Requirements of Subgrade, Base, Binder Course and Surface—Nature and Properties of Asphalts—Failures

By T. L. Crossley*

Composition.

The four essential parts of a sheet asphalt pavement are: (1) Subgrade or foundation; (2) concrete base; (3) binder course; and (4) surface or top.

Subgrade.

A proper study of this important element is essential. It is the portion of work most affected by local conditions of soil and topography. Soils may be roughly divided into three main classes, though, of course, there are several variations of each: (1) Gravelly or sandy; (2) loamy; and (3) clay. The first two classes present the least difficulty to the asphalt engineer. They drain well, and surface waters are not likely to be in contact with the concrete base, thus avoiding frost troubles. Backfilling of excavation can be thoroughly done by watering, with considerable saving of labor and time. The preparation of the grade to good crown and smooth surface is also less expensive. Where the town site is on a slope of light alluvial soil at no great depth over rock or hardpan some measures should be taken to prevent shifting of soil under sheets running at right angles to direction of slope.

Clay represents the extreme of difficulty in preparing subgrade. Many elaborate means of subdrainage have been used. Different cases call for different treatment, but common sense is of more value than precedent in many cases, the object in view being the rapid elimination of water from the soil immediately under the concrete base.

Preliminary to the preparation of subgrade and of considerable importance is the proper condition of sewers, gas, water, and wire mains. These should be closely looked into, repairs made, and trenches very carefully backfilled. In many cases cable, water, and gas mains may be located at sides of roadway, so that subsequent repairs will not necessitate breaking up of pavement. It is almost impossible to patch a pavement so that the repair will not present an increasingly noticeable defect. Small towns growing rapidly should be especially careful about the consideration of such pavements, taking plenty of time to find out what future requirements of underground work may arise.

Concrete Base.

The subgrade being satisfactory, or considered so, the concrete base is laid. A 1:2:5 or 1:3:6 cement concrete is used, and, except in very narrow streets, should be six inches thick. The surface should be true to crown and free from depressions. The finish should be given by a heavy template. It must be borne in mind that a sheet asphalt surface is not a solid, but a more or less fluid, body, and will conform to any variation in the fixed concrete on which it rests. It is impossible to get a smooth asphalt surface over a rough concrete base. It may look right when rolled, but a year under traffic will serve to show on the surface the profile of the base.

Binder Course.

This is laid on the concrete base, and consists of crushed stone and asphalt as a rule. It is essential that the concrete be thoroughly set and dry. If this is not the case there is great risk not only to the base itself, but that the moisture given off will honeycomb the binder and surface courses, causing rapid deterioration of the pavement.

There are two forms of binder course—"closed" and "open."

Closed binders consist of crushed stone and coarse sand. The stone should not be "crushed run," as this contains too much fine material, presenting an unnecessary amount of surface. This requires more bitumen, and is difficult to lay smoothly.

Closed binders should contain little or no material passing 60 mesh sieve, about 15 to 20 per cent. passing 10 mesh, and about 20 to 25 per cent. passing 4 mesh; remainder should pass 1 in. ring for 1¼ course or ¾ in. ring for 1 in. course, to prevent possibility of excess of oversize. This would require for coating about 4 to 4.5 per cent. of bitumen. Open binder should consist of crushed stone which has been screened free of sizes under ¼ in. It will require about 3 to 3.5 per cent. of bitumen.

Binder course should look bright and glossy when laid. If it appears dead and dull it has been overheated or contains fine material in excess. "Open" binder should always look bright. If the trucks bringing binder to the street are dripping noticeably, or if on spreading the binder there is a spot completely filled with bitumen, an excess of bitumen is being used. Such spots if of larger area than one square foot should be removed. One way of preventing this trouble is to dump the truck ahead of requirements to such a distance that all material must be shovelled over. If any large spots of this nature are left the excess of bitumen is liable to be drawn into the surface course, under the influence of the sun, and give rise to soft spots in the pavement.

It is the practice with some contractors to use a harder bitumen in the binder course, about 10 points on the penetrometer. If a penetration of 65 to 70 degrees is used for the "top," then 55 to 60 degrees would be used for the binder. I believe the idea is that the mass is held together rather by the tensile strength of the bitumen than by its surface tension. The voids are large, and are not filled with the bitumen as in surface mix. This is, in my opinion, an unnecessary refinement, and even faulty in the case of a street with light traffic in a cold climate, having a greater tendency to crack by contraction.

Surface or Top.

This consists of bitumen, filler, and sand. The Trinidad asphalt, containing about 30 per cent. of finely divided mineral matter, requires no additional filler, but has to be fluxed with a specially prepared heavy asphaltic oil to the required consistency before being mixed with the sand aggregate.

In addition to sand, dust is required as a filler, to utilize the malthas or liquid asphalts. The science of controlling these aggregates has been developed to such an extent in America that the present use of natural rock asphalts is very limited here, being confined to cities and town within very short haul of the deposits of the bituminous limestone or rock asphalt. Where the rock asphalt is used, the whole of the surface material is hauled; whereas with the liquid asphalts only the 10 or 12 per cent. of bitumen is hauled, the material for the aggregate being generally obtained locally.

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* Extract of paper before the Canadian Society of Civil Engineers

The filler is cement or limestone dust, preferably cement, and the mixture of sand and cement is graded from 200 mesh to 10 mesh. Sands do not behave in the same way with bitumens; some will hold more than others. In connection with the filler it is desirable, especially if heavy traffic is expected, that a large proportion of the 200 mesh material shall be dust that will remain suspended in water for 15 seconds, otherwise the fine material is sandy, and will not make a road to stand heavy wear. The finest of sands may have about 30 per cent. of voids—in fact, it has been shown that the voids in sand do not vary much over quite a wide range of size. The life of an asphalt surface depends on the filling of voids and the complete covering of all particles with bitumen. Speaking generally, a surface mixture may contain bitumen equal to 10.5 to 12.0 per cent.

Filler (200 mesh) 12 to 15 per cent. Three-quarters of this material should be fine enough to remain in suspension in water for 15 seconds. Sand—100 mesh, 13 per cent.; 80 mesh, 13 per cent.; 50 mesh, 15 per cent.; 40 mesh, 15 per cent; 30 mesh, 10 per cent.; 20 mesh, 10 per cent. Local conditions, however, may occasion considerable variations. Sand should be sharp and clean. The objection to a dirty sand does not lie in the fact that fine silt is present, but because the particles of such a sand are coated with this silt, and therefore are not brought into complete contact with the hot asphalt when the mixture is made.

If local conditions make it necessary to use such sand it might be cleaned by passing through a revolving screen or by dropping down a vertical chute on to a baffle plate.

The surface mixture is brought to the street in trucks and dumped on the binder at a point somewhat in advance of requirements, so that it will be necessary to turn over the whole load by shovelling and wheeling to working area. It is not good practice to dump at the spot where it is to be raked. It is a practice sometimes to smear the bottom of the truck with asphaltic oil to facilitate dumping. This is unnecessary, and there is a danger of using too much oil and producing soft spots in the surface. The mixture should be at 300 degrees F. when dumped, and should not be dumped if less than 275 degrees F. At lower temperatures it is difficult to rake out and roll smooth.

Preparation of Specifications.

In connection with a contract for paving with asphalt in any of the various methods, the inspecting engineer and chemist are or should be called into cooperation at the earliest stages of the proposed work. They should know local conditions of soil, drainage, and traffic. With these in view, specifications should be drawn up. It has been too frequently the practice to copy specifications of other cities, especially where these are known or reputed to have good pavements.

This question of reputation is sometimes a happy accident or the result of a trip over a few streets by a more or less qualified committee in a car belonging to the head of the roads department.

Especially to be avoided is the inclusion in a specification of some feature introduced with success in one or more cases to counteract some special local condition or on account of the local availibility of some special material. Richardson cites a case wherein an engineer specified cinders for subgrade drainage and insisted on their use. A large quantity was used, subject to a 200-mile haul, when good gravel was available within easy carting distance.

In drawing up specifications for the sand aggregate of a sheet asphalt pavement the question of sand supply should be studied and the best grades from this supply should be specified. This will forestall the necessity of permitting variants from specifications.

The following is suggested as a preamble to specifications for a sheet asphalt paving:

Specifications for Sheet Asphalt Paving.

Town of ....

Preamble.

The object of these specifications is:

1. To provide a means of ensuring that a first-class sheet asphalt pavement be laid in the Town of ....

2. To regulate the conditions under which it shall be laid; and

3. To state what limits of chemical and physical properties in the materials used shall be deemed sufficient and expedient to that end.

Parties tendering to supply and lay pavements under these specifications will be compelled to comply with the conditions set forth, in every detail, without recourse, excepting only as follows:

(a) That notice shall be made in writing, duly signed, and embodied in their tender, of any variants which the conditions of manufacture or experience of contractors makes desirable.

(b) That said variants be acceptable to the engineer and chemist as not being prejudicial to the laying and maintenance of a first-class sheet asphalt pavement. Variants so permitted shall not be held to diminish the responsibility or guarantees of contractors in any way.

Sheet Asphalt Pavements.

The bitumens are divided roughly into two classes—the bitumens and pyrobitumens. Bitumens include the asphalts, malthas, and paraffins. Pyrobitumens include coals, lignite, and peat. The bitumens used for pavement work are known as asphalts. These may be divided into rock asphalts, asphalts, and malthas. Rock asphalts or bituminous limestones: Sicilian and Val de Travers, Switzerland. Asphalts: Trinidad Lake asphalts, called natural solid bitumen, and containing about 35 per cent. of mineral matter finely divided. Bermudez or Venezuelan, which is thought to be related to the Trinidad deposit, though it contains but 3 or 4 per cent. mineral matter. Malthas or oil asphalts: Mexican, Californian, Gulf States, Canadian Northwest.

The term asphalt is now used to describe a bituminous material having certain chemical and physical properties apart from its origin. The chemical and physical characteristics of the proved asphalts are great adhesiveness and cohesiveness, non-crystallization, minimum change in properties by heat treatments for several hours at temperatures up to 500 degrees F. They consist in large measure of cyclic hydrocarbons. It is the condensation of carbon atoms in this condition that leads to the danger of free carbon or high fixed carbon if the heating, described later, be carried out carelessly. Five important areas produce bitumens likely to be used in Canadian paving work. These are the Trinidad asphalt lake on the Islands of Trindad, the Bermudez Lake in Venezuela, the Mexican fields, the Californian and Texan fields. Besides these it is hoped that soon a Canadian Northwest asphalt field will be developed. Historically Trinidad asphalt was used for first sheet asphalt paving in Washington, D.C., in 1876, and about twelve years later pavements were laid in Montreal. Some portions of pavement laid over twenty years ago in Montreal with rock asphalts on parts of Dorchester Street, Mountain Street, and the streets in the neighborhood of the Board of Trade Building are still under traffic, I am told.

The Trinidad lake is situated less than a mile from tidewater. The crude asphalt containing some water is mined with mattocks and transported by aerial tramway to the steamers. The Bermudez lake is nine miles from tidewater, the material being mined in much the same way. The Mexican and Californian fields consist largely of wells yielding what is known as malthas.

The Trinidad lake asphalt contains about one-third its weight of mineral matter, the Bermudez asphalt only 2 or 3 per cent., and the malthas a few tenths of 1 per cent., or only traces.

The asphalts and malthas must be refined before use. Refining has two objectives—(a) removal of water and light oils; (b) reduction of the crude bitumens to a definite consistency. These objects are attained by heating the crude in stills with agitation by dry steam. If this were to be done by air certain oxidized products would be obtained which would thicken up the asphalt and reduce its surface tension. Care has to be taken that the steam admitted to the stills for agitation is quite dry, otherwise foaming would occur, causing great trouble.

The product obtained by heating the crude as above is known as refined asphalt. This material is usually too hard to be used in surface mixtures for sheet asphalt, and must, therefore, be fluxed. Fluxing is done by mixing with the refined asphalt a proportion of heavy asphaltic oil defined within close physical limits. The material obtained by fluxing is known as asphaltic cement, or "A. C.," and it is this product which is used in paving work. It is becoming more common with companies engaged in the asphalt business chiefly to make A. C. direct by stopping distillation as the desired consistency is arrived at. This makes it a simpler matter for contractors at distant points. Only one material to be tested instead of three and only one substance to be heated, no delicate mixture of flux and refined asphalt which calls for special arrangement and knowledge.

Failure of Asphalt Pavements.

Generally speaking, sheet asphalt pavements do not wear out. They "fail" owing to some constructional defect. Failures have occurred from all four parts of the pavements—subgrade, concrete, binder, and surface.

Subgrade failures are due to (1) careless backfilling; (2) too great haste in laying pavement where much backfilling is done; (3) insufficient drainage. Adequate examination of the soil and preparation of subgrade is, therefore, imperative.

Concrete failures are due to (1) lean mixture; (2) laying of binder before concrete is thoroughly set and dry; (3) use of dirty sand; and (4) use of old cement. Binder failures are due to (1) insufficient bitumen; (2) burned bitumen; (3) laying on wet concrete; (4) dirty concrete; (5) binder too cold; (6) excessive oversize in aggregate; (7) lamination in crushed stone; (8) overrolling of binder when cool; and (9) traffic on binder before top is laid.

Surface failures are due to (1) too little filler with heavy traffic; (2) too much filler with light traffic; (3) too much or too soft bitumen under heavy traffic; (4) too hard bitumen under light traffic; (5) laying top on wet binder; (6) insufficient consideration of climate extremes; and (7) frost working in at car tracks or curbs.

In the writer's observations failure is due more frequently to binder troubles than to other causes. Attention is focussed on the laying and appearance of "top" to the neglect of binder. With a smooth concrete base and a medium close binder well laid it should be quite safe to cut down the "top" thickness to three-quarters of an inch.

Reinforced Concrete Ship Construction

New Methods Devised to Meet the Special Requirements—Steel Framework — Concrete Applied by Compressed Air — Future Developments

By Carl Weber*

THERE is, without question, a great future for reinforced concrete in ship construction. The first attempts have necessarily been crude and have therefore not always been entirely successful. However, we must not forget that all great inventions, especially in ship construction, have been the results of scientific development of ideas which often were introduced by laymen in a very crude form, and were later, with the assistance of experimental marine engineers transformed into the great successes of the present day. Compare the steamship of to-day with the first vessels of this kind. Consider the difficulties which had to be overcome in introducing iron and steel in ship construction and you will probably agree that the concrete ship of the future will undergo the same development, and, of course, will also be a great success after the combined experiences of the marine and the concrete engineer have come to its assistance.

I have made the building of concrete ships one of my life's problems, and have carefully studied the scientific principles which must be adopted in order to insure success. Not only for the construction of smaller vessels, as barges and scows, is concrete an entirely suitable material, but also for large ocean-going ships will its use be perfectly safe and extremely advantageous.

The principal faults of all previous attempts at concrete-ship construction have been that concrete builders tried to use everyday methods and means in design and mixing and applying the materials. Most of these vessels were built of ordinary concrete mixed and placed in the common way. The special requirements of ultimate service were not sufficiently taken into consideration. The designs were made without consultation with marine engineers, and the strains which the empty and the loaded ship had to resist under all the different and changing conditions were only more or less intelligently guessed at.

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*President Cement-Gun Construction Co., Chicago

In spite of all this, however, satisfactory results have been obtained in most cases, and therefore the subject is worthy of careful consideration and encouragement, especially at this time when the production of freight ships is one of the greatest problems of all nations.

Two Methods of Construction

So far two methods have been used for the construction of concrete barges:

The first method consisted in building an inside and outside form for the ship's hull, and between these forms (which were separated to allow for intended wall thickness) the necessary reinforcement was placed. Then a concrete, composed of Portland cement, sand and crushed stone or gravel, was poured in a semi-liquid condition to fill the forms and to incase the steel reinforcement. After the concrete had sufficiently hardened, the forms were removed and the barge was finished by pouring bulkheads, division walls, decks, etc., in a similar manner.

This method resulted in extremely clumsy and heavy vessels, which can only be used for sand and construction barges. The ship itself is unelastic, and in collision with wharfs and other vessels dangerous cracks develop which are difficult to repair and which will often result in loss of the entire ship.

The second method consists in using a light steel skeleton, placing over the outside of it an expanded metal or wire fabric and finishing the hull by plastering over this sheathing a rich mortar coating in the same manner as light curtain and partition walls are formed in fireproof-building construction. This method is a great improvement over the first one, but can only be used for smaller boats, launches, etc., and, of course, is practically out of the question for freight barges.

New Methods Solve the Problem

I have invented and developed a series of entirely new methods of construction which not only solve the problem in a scientifically correct manner, but allow the building of large and small concrete vessels of remarkable elasticity and of comparatively light weight. In addition to this, the cost of construction is greatly reduced because no forms are required. All concrete is handled, applied and finished by machinery especially designed for the purpose. The risk of poor workmanship is almost completely eliminated.

Owing to the present international patent situation, I am not able to publish complete details of construction. In order, however, to give some advance information to your readers who are interested in the subject I will here explain the general outlines of the methods employed in my systems:

A Steel Framework

The ship's hull consists of a strong framework of steel, which is so designed that the combined strength and advantages of steel and concrete are fully recognized. This truss frame is erected and riveted in the ordinary manner. In the completed ship the steel frame is entirely incased in concrete and thereby protected against rusting. By this incasing the steel members are also stiffened and the buckling stresses are greatly reduced. For this reason the steel members of the frame are of simple design and relatively light weight.

After the steel frame is completed it is covered with my multi-unit wall construction of varying thickness. The walls are formed of a high-grade concrete applied by compressed air, and each section is independently reinforced by networks of light steel bars and wire mesh. All ship walls, bulkheads, decks and partitions are formed in a similar manner without the presence of any construction or connection joints, so that the completed ship is one seamless, monolithic structure.

The concrete is composed of Portland cement and crushed quartz or other suitable stone material. All pieces not passing a ½-inch screen are rejected. These materials, with the necessary waterproofing medium and the water for proper hydration, are mixed and ground together, and before being placed are properly conditioned to reduce the danger of cracking because of excessive expansion and contraction.

Special Machine Applies the Concrete

The material so prepared is applied in even and uniform layers by means of a powerful stream of compressed air with a special machine named the "Tector," especially designed by me for this purpose. For the material combination thus described the name "Torcrete" has been adopted. It is really a waterproof concrete of highest possible quality.

After the last coat of Torcrete has sufficiently hardened, the outer surfaces are rubbed down to an even, smooth finish with rotary compressed-air-driven grinders, and the entire ship may be painted as usual.

These, of course, are only the general outlines of future cement, or rather Torcrete, ship construction. These methods can also be advantageously employed for reconstruction and repair of old steel ships and for placing of bulkheads, tanks and decks in old hulls.

The principal advantage of the Torcrete ship are its low cost and the rapidity with which such vessels can be built. However, even at a considerably higher price, its use would be of greatest value for cargoes which require even temperatures and which are destructive to steel. For tank barges, ore and coal boats, refrigerator ships and similar vessels, the advantages of a non-rusting ship will be quickly recognized. Improvements will be made as quickly as the development suggests, and, of course, the combined experiences and efforts of marine, concrete and structural engineers must be utilized to the fullest extent.

Ships to be Built

It is quite likely that within the next few months several of these ships will be built, amongst others, large Torcrete tank barges for Mexican oil trade containing approximately 40,000 barrels of crude oil. These barges will have an all over length of 310 feet, a beam of 56 feet, and will be designed for 20 ft. draught of the loaded vessel.

I am also negotiating with some eastern interests for the construction of a large fleet of coal and ore barges, and we have in this construction undoubtedly one of the latest and greatest advances in the engineering science of recent years. There is no question but that this system of ship construction will be of great value to Canadian interests, and I hope it will be only a short time until I am able to start actual construction work in Canada.

Concrete Roads of Doubtful Economy

IN a letter addressed to the New Jersey Commission on Road Legislation in reply to a request for suggestions regarding financing, construction and maintenance of roads, J. W. Howard, consulting engineer of New York City, discusses road and pavement economies and the matter of maintenance as the real problem in road work. A considerable portion of his letter is devoted to a discussion of the concrete roadway, and he gives it as his opinion that wearing surfaces of concrete do not have the qualities of perfection usually associated with them and considers their use as a case of doubtful economy.

As an example of the doubtful economy of first construction, combined with the danger of difficult and expensive eventual maintenance, the writer believes a warning is necessary against the use of much capital of taxpayers by bonded debt or otherwise, for more Portland cement concrete roads with surfaces of the same material, until experience and reliable cost data of maintenance for a reasonably long period of years show whether or not the concrete roads now being tried can be maintained in constant good condition and at a reasonable rate per square yard of area per year; and for how long.

A Systematic Propaganda.

There are many articles appearing in the press all over Canada and the United States urging cement concrete roads in such a way as to indicate a systematic propaganda and promotion of the sale of cement for concrete roads. Large sums seem to be expended for advocating concrete roads; including press bureaus, commercialized conventions, lectures, taking delegations of officials, etc., to concrete roads, having moving pictures shown, etc. The boldest assertions are made. For instance, a Texas paper has this erroneous statement:—"United States government reports show the cost of upkeep of concrete pavement is lower than any other type. It is the most economical, has the longest life; consequently the most efficient."

The Kansas City Journal, August 17th, 1916, gives an address by Mr. G. A. Ricker before the Commercial Club there, saying: "Maintenance and upkeep are also important elements in the construction of a road. This side of the work is often neglected, but it is of the utmost importance. Any road, no matter what material, is bound to wear with time and service." All of which is true, but he added the misleading statement: "The upkeep of concrete roads is less than $50 per mile per annum." It would be interesting if he would produce official, reliable data of a number of concrete roads, giving age of each, quantity, quality and costs of repairs on unit bases per year for each, and the conditions of each road during and at the end of the period of years recorded.

The New York Sun, December 15th, 1916, prints an article by James Brooke, "Road Expert of the Portland Cement Company," on "Epoch of Good Roads," which advocates concrete and makes the unsupported assertion: "The experience in various states has fixed the repair expense of 16-foot concrete roads at about $50 per mile per year."

That this estimate of Mr. Ricker and Mr. Brooke is much too low is shown by the fact published by Mr. F. W. Starr, Deputy Commissioner of New York Highways, that 84 miles of concrete roads of the best or first class in New York State cost $129 per mile for maintenance during 1915 and "these pavements are of recent construction, the average being one year." It is evident that the rate of maintenance will enormously increase as the roads grow older, especially because I learn those repairs were only enough to make the roads passable and general repairs will, eventually be needed over the entire roads.

Mr. A. H. Hinkle, Deputy Highway Commissioner of Ohio, publishes statistics showing that 107 miles of concrete roads there, constructed from 1912 to 1915, cost $163 per mile for such repairs as were done during 1915; the average age of these roads being only about two years.

The writer believes that unprotected concrete is not, in the end, a suitable wearing surface material to resist weather and traffic, and that Portland cement concrete surfaces cannot be kept in constant good and economic repair for a long term of years, surely not as constantly and economically as several other long used, established types of road surface layers. I agree with a former article by the same Mr. G. A. Ricker, C.E., then Deputy Commissioner of New York Highways, in which he said: "Concrete may be used to advantage where soil conditions preclude other treatment, but it should be always as a foundation for some suitable top or wearing surface. After having been engaged in building many kinds of concrete structures, it is the writer's opinion that concrete as a road material cannot be so protected (with Portland cement mixtures) as to insure a permanent structure, since it cannot be maintained in suitable condition for use and becomes a nuisance that must be removed."

Industry Depends on Taxpayers.

There is reason to believe that taxpayers will be saved much money if Portland cement is used only in permanent road foundation, called the base, which has been successful everywhere for sixty years. Cement manufacturers would thus continue the sale of cement for all future years in connection with many thousand miles of roads, which must be built with solid foundations, having the road surfaces made of long established, standard, thick wearing surface layers of asphalt compositions, bricks, stone blocks, etc., protecting the permanent supporting concrete base below. These standard wearing surface layers, where used in locations for which each is best adapted, have been for years and can continue to be easily maintained at comparatively low cost per year for any number of years, where small repairs are promptly made on the principle that "a stitch in time saves nine."

Portland cement manufacturers who advocate constructing entire roads, both base and wearing surface, of concrete, may thereby earn temporary profits, but after a few years when such roads require repairs at more than a thousand dollars per mile per year and entire new roads will eventually be needed, then communities will be in debt with no resources to pay for new roads of any kind, nor properly repair such old roads. The cement industry will have "killed the hen which laid golden eggs." It would be a better policy to foster a continuous sale of cement for road foundations and in the end more profitable to thus serve the taxpayers and users of roads, upon whose goodwill that industry, in this field, must eventually depend.

Can. Soc. C. E. Committee Reports

For Presentation at the Annual Meeting Jan. 23-25, 1917, Published in Advance for the Information of Corporate Members

REPORT OF COMMITTEE ON CONSERVATION

General Review of Conservation Work in Canada During 1916

The advance of conservation, of general industrial improvement, in Canada has been impelled and facilitated during the past year by the most powerful stimulus. Progress toward the better utilization of the resources of the Dominion has naturally attained greater momentum in the form of a national necessity than it could be expected to achieve as an inadequately realized desirability, awaiting the creation and support of effective public sentiment. The events of 1916, and especially of the past few weeks, have served to emphasize more forcibly than ever, the relations of economic efficiency to national strength and safety.

Among the concrete achievements of the past year, the conclusion of a treaty whereby Canada and the United States will co-operate in the protection of migratory bird life should prove of inestimable service to agricultural and forest production, the two chief branches of Canadian primary industry. The material importance of this measure, and the utility of the insectivorous bird life which it is designed to protect, may be judged from the statement, based on reliable authority, that the annual loss in the United States from the depredations of insects amounts to $800,000,000. This international action to preserve the insectivorous and game bird resources of North America as a permanent asset, stands as a pre-eminent feature of conservation progress during 1916.

As a result of recent action the future economic development of the Dominion will benefit by the aid and guidance of systematic, industrial research. The appointment of the Industrial Research Commission by the Dominion Government and the corporate enterprise of the Canadian Pacific Railway in promoting scientific research will enable Canadian industry to utilize the services of two highly organized institutions. In the same manner as the forest industries are now in receipt of the services of the Forest Products Laboratories at Montreal, every form of industry should be enabled to avail itself of expert assistance in the solution of its peculiar problem. To achieve the maximum results industrial research must be linked up with a thorough system of technical education.

Town planning progress merits special mention as a conservation movement. Aside from its bearing on public health, town planning seeks the economical use of public funds. During the opening decade of the century, Canada invested approximately $600,000,000 on municipal growth, largely for civic improvements. Heavy additional expenditures have been made since 1910. The efficient investment of capital on such a large scale cannot be secured as long as municipal development continues in haphazard manner. Adequate legislation and administrative machinery must be provided to control and guide urban expansion. During the past year distinct progress has been made in this direction and it is hoped that every province in the Dominion will shortly possess proper provision for thorough control of housing and town planning.

In practically every branch of primary production and natural resources, the war has created special conditions and conservation problems. In many instances, the national waste due to failure to utilize our opportunities to the full extent has been greatly reduced. This applies particularly to water powers, the development of which is proceeding rapidly. Similarly, with regard to mining, renewed activity in both basic and subsidiary undertakings has taken place and thorough study of the status of our mineral industries has been undertaken. The fishing industry has been stimulated by the unprecedented demand for Canadian fish to relieve the shortage in the United Kingdom. Experiments have been undertaken to ascertain the possibility of securing profitable utilization of the immense amounts of fish offal which have hitherto been entirely wasted. It is hoped to furnish the fishermen with practical methods of converting this material into valuable products.

As regards agriculture, the Federal and Provincial Governments, as well as railway and other agencies, are taking steps to promote after war settlement on an extensive scale and in an improved manner. With the proper guidance of colonization, with adequate provision for marketing facilities, rural credits and social intercourse, a rapid increase of productive areas should be attained.

It is gratifying to record the decision of the Ontario Government to remodel its forest protective service along the most approved lines. The remarkable development of our pulp industry indicates the potential value of our forests and the wisdom of affording the most efficient protection obtainable. The work of determining the extent of our timber resources progresses steadily. Surveys of British Columbia and Saskatchewan forests have been completed during the past year.

Members of Committee

James White, Chairman, G. A. Bayne, W. H. Breithaupt, E. E. Brydone-Jack, H. J. Cambie, J. B. Challies, John Chalmers, C. R. Coutlee, J. S. Dennis, C. E. W. Dodwell, A. E. Doucet, J. B. Hegan, H. F. Laurence, R. S. Lee, R. W. Leonard, R. McColl, Wm. McNab, A. J. McPherson, C. H. Mitchell, W. R. W. Parsons, E. T. P. Shewen, R. O. Sweezey, T. H. Tracy.

THE INTERNATIONAL ELECTRO-TECHNICAL COMMISSION

This Committee begs to report that during the year 1916 the work of the Commission, as in 1915, has been more or less restricted, due, of course, to the war, which must of necessity materially affect all international bodies.

In June, however, we had the pleasure of a visit from Mr. C. Le Maistre of London, England, the General Secretary of the Commission, our committee meeting in Ottawa and discussing with Mr. Le Maistre various matters relating to the Commission's present and future activities. At that meeting Mr. Le Maistre stated that while matters naturally could not go ahead in just the same way as formerly, still everything possible was being done by the Central Office and the various sub-committees to put things in shape so that material progress can be made shortly after conditions return to normal.

Mr. Le Maistre also spent considerable time in the United States in consultation with the American Committee and the American Institute of Electrical Engineers, meeting them on behalf of both the Commission and the British Engineering Standards Committee, of which latter body Mr. Le Maistre is also a member, and has since been made Secretary. His visit will undoubtedly materially advance the cause of international standardization.

Nothing has, of course, been done during the past year towards the holding of any further Congresses. Presumably the 1917 meeting, originally scheduled to be held in Petrograd, will be postponed.

We have pleasure in reporting that Prof. L. W. Gill, the member of the Canadian Committee who is at the front, continues to command a battery somewhere in France.

With the exception of Mr. W. A. Duff, of Winnipeg, who, we are sorry to say, resigned during the year, the committee remains as before.

Members of Committee

L. A. Herdt, Chairman, O. Higman, Vice-Chairman, H. T. Barnes, L. W. Gill, J. Kynoch, J. Murphy, T. R. Rosebrugh, A. B. Lambe, Secretary.

REPORT OF THE COMMITTEE ON ROADS AND PAVEMENTS

The work of the Committee during the past year has been confined chiefly to the following:—

1. The collection of data concerning the construction of various types of roads and streets.
2. The formulating of specifications for the supply of crushed stone, gravel and sand.
3. The formulating of a tentative specification for three grades of asphaltic road oils.

Specifications for the Supply of Materials.

The formulating of specifications for natural products, such as crushed stone, gravel, and sand, which can be directly used in all localities, is impossible. In many localities the greater portion of the cost of these materials is that paid for transportation. Hence material of high quality which can be procured within short distance of the work in one locality would reach a prohibitive cost in another.

The committee has therefore endeavored to draw up specifications which cover materials of good quality under normal commercial and natural conditions. It is recognized that in some districts these specifications as they stand will not be applicable, but the ideal striven for has been to secure a specification that may be a guide, from which specifications best suited to local conditions can be drafted.

The classifying of materials into different grades according to qualities reduces the necessity of redrafting the specifications. In localities where materials of certain grades cannot be secured economically and the nature of the work permits the use of material of inferior qualities, it will only be necessary to specify the particular grade required when the specifications for work are drafted.

The extensive use of laboratory tests results may be considered inadvisable by some engineers. At the present time laboratories are not available in all municipalities, but resort to laboratory tests is rapidly growing, and even at the present time tests are being conducted by some of the universities in the Dominion. It is felt that it is only a matter of time till every large municipality will submit all materials to laboratory test prior to accepting them.

The properties assigned to the different grades have been selected from the study of results of tests made under the direction of the chairman of the committee, as well as from the study of the results of tests conducted by various highway organizations.

In reading the specifications it must be borne in mind that they are for the supply of materials only. The classes of work in which the materials are to be used, unless such materials are confined only to such classes, have not been stated. The specifications for the construction of various types of pavements will state definitely the class, size, etc., of the materials which are to enter into the construction of the particular pavements.

Drafts of the specifications as considered by the members of the committee residing in Toronto were sent to all members. Where suggestions regarding changes in minor points were made these have been incorporated, but where changes of importance have been suggested these are indicated at the end of each specification in order that they may receive the consideration of the society. The specifications are shown in Appendix II.

Specifications for Bituminous Materials.

The committee also begs to report progress in the drafting of specifications for the supply of bituminous materials. The rapidly increasing use of these materials for the protection of road surfaces renders it advisable that a reliable specification be in the hands of engineers at the earliest moment.

Work was commenced on three grades of asphaltic road oils, but at the same time it was realized that there were a number of other grades of this material as well as refined tars, etc., favored by engineers. The specifications submitted in Appendix III. have not been placed before all the members of the committee, and are therefore to be considered as a progress report only.

It is the intention of the committee that a series of general clauses be drawn up which will take into consideration suggested form of tenders, suggested system of payments and methods of inspection of materials. The tentative specifications for asphaltic oils are shown in Appendix III.

[Appendix I. of the report, inserted at this point, contains a list of pavements reported on by some fourteen different municipalities, towns, and cities.—Ed.]

APPENDIX II.

Standard Specification Roads and Pavements for Consideration at the Annual Meeting, 1917.

ITEM 1.—CRUSHED STONE

Definition.

1-1.—Crushed stone shall be bedded rock or boulders which have been broken by mechanical means into fragments of varying shapes and sizes. It shall not contain more than 10 per cent. by weight of soft or friable material. Material of which the particles are coated with dirt or have the edges worn off will not be accepted.

Weathered Stone.

1-2.—No crushed stone shall be accepted which shows signs of being disintegrated or reduced in quality by the action of the weather.

Crusher Run.

1-3.—Crusher run shall be the product of the crusher, of which not more than 8 (eight) per cent. by weight shall pass a ¼ (one-quarter) inch opening.

Sizes of Stone.

1-4.—The following schedule of sizes shall be used, with the percentages of material larger than the maximum and smaller than the minimum openings respectively, as shown. The sizes of opening shall mean the diameter of circular openings in steel or iron plates. The percentages shall be determined by weight.

The sizes of stone with the openings by which they are obtained are as follow

Name of size	Maximum size of opening in inches	Maximum per cent. retained by maximum size of opening	Minimum size of opening in inches	Maximum per cent. passing minimum size of opening
5 inch	5	3	4	8
4 "	4	3	3	8
3 "	3	3	2½	8
2½ "	2½	5	2	10
2 "	2	5	1½	10
1½ "	1½	5	1	15
1 "	1	5	½	15
½ "	½	7	¼	15

Screenings.

Screenings shall be material all of which shall pass a ¼ (one-quarter) inch screen.

Mineral Dust.

Mineral dust shall be finely pulverized stone, of which not less than 80 (eighty) per cent. by weight shall pass a 200 mesh screen.

Tests on Stone.

1-5.—In addition to fulfilling the foregoing requirements, crushed stone shall be classed into three grades, according to qualities which shall be determined by tests conducted in a properly equipped laboratory. The properties determined shall be: Coefficient of wear, toughness, and absorption. Material meeting the requirements of any of the grades with respect to coefficient of wear and toughness but failing to meet the requirement with respect to absorption may, on consideration of the engineer, be classed with the higher grade.

Grades of Crushed Stone.

Crushed stone shall be classed under one of the following grades:

1-6.—Grade "A" is a rock which has a toughness of not less than 18 (eighteen), a coefficient of wear of not less than 14 (fourteen), and an absorption of not more than 0.6 (six-tenths) pounds per cubic foot.

1-7.—Grade "B" is a rock which has a toughness of not less than 10 (ten), a coefficient of wear of not less than 7 (seven), and an absorption of not more than 1.0 (one) pound per cubic foot.

1-8.—Grade "C" is a rock which has a toughness of not less than 7 (seven), a coefficient of wear of not less than 5 (five), and an absorption of not more than 1.5 (one and five-tenths) pounds per cubic foot.

1-9.—Grade "D" is a rock that does not meet the requirements of any of the above grades, and which may be used only on consideration by the engineer.

ITEM 2.—GRAVEL.

Definition.

2-1.—Gravel shall consist of naturally-formed fragments of tough, durable rock, well graded in size from the smallest to the largest, free from flat, elongated particles, and shall not contain more than 15 per cent. by weight of soft, friable material. It shall not contain an excess of clay nor an excess of loose or adhering dust, vegetable loam or other deleterious matter. It shall be satisfactory to the engineer in all respects.

Screened Gravel.

2-2.—"Screened gravel" is gravel fulfilling the above requirements which is screened into one or more of the sizes defined in section 1-4 of the "Specifications for Crushed Stone."

2-3.—"Run of bank gravel" is gravel fulfilling the requirements of section 2-1 of this specification, which shall be classed under one of the three grades shown below according to qualities determined in a properly-equipped laboratory. The properties determined shall be the coefficient of wear and the proportions of the various sizes of particles present.

The co-efficient of wear shall be determined on material passing a screen having circular openings 2 (two) inches in diameter and retained by a screen having circular openings ½ (half) inch in diameter. The test shall be conducted in the same manner as that for determining the coefficient of wear of crushed stone. Run of bank gravel shall be classed according to the following grades:

2-4.—Grade "A" is a run of bank gravel containing a large percentage of pebbles of igneous rocks. It shall not contain more than 5 (five) per cent. by weight of material which shall be retained on a screen having 4 (four) inch circular openings, and not more than 45 (forty-five) per cent. by weight of material which shall pass a screen having ¼ (one-quarter) inch square openings. It shall not contain more than 3 (three) per cent. by weight of clay or loam nor have a coefficient of wear of less than 14 (fourteen).

2-5.—Grade "B" is a run of bank gravel containing a smaller percentage of igneous rock pebbles. It shall not contain more than 5 (five) per cent. by weight of material which is retained by a screen having 4 (four) inch circular openings nor more than 60 (sixty) per cent. by weight of material retained by a screen having ¼ (one-quarter) inch square openings. It shall not contain more than 9 (nine) per cent. by weight of clay or loam nor have a coefficient of wear of less than 11 (eleven).

2-6.—Grade "C" is a run of bank gravel composed chiefly of pebbles of sedimentary rock. It shall not contain more than 5 (five) per cent. by weight of material which is retained on a screen having 4 (four) inch circular openings, and not more than 80 (eighty) per cent. by weight of material which passes a screen having ¼ (one-quarter) inch square openings. It shall not contain more than 12 per cent. by weight of clay or loam nor have a coefficient of wear of less than 7 (seven).

2-7.—Grade "D" is a run of bank gravel which does not meet the requirements of any of the above grades and which may be used only by written permission of the engineer.

2-8.—When so directed by the engineer, gravel shall be crushed. The material so produced shall conform to the requirements of "screened gravel" or "run of bank gravel," as directed by the engineer.

ITEM 3.—SAND.

Concrete Sand.

3-1.—Fine aggregate for concrete shall consist of natural sand, composed of hard, tough, durable particles, graded from fine to coarse. When dry, not more than 5 (five) per cent. shall be retained on a sieve having 4 (four) meshes per lineal inch; not more than 20 (twenty) per cent. by weight shall pass a sieve having 50 (fifty) meshes per lineal inch, and not more than 4 (four) per cent. shall pass a sieve having 100 (one hundred) meshes per lineal inch. It shall not contain more than 3 (three) per cent. by weight of clay or loam.

Mortar Tests.

3-2.—Sand, in addition to meeting the above requirements, shall give a mortar strength equal to or higher than the minimum value at any of the ages shown in the following table:

Age at test.	Minimum strength of 1:3 mortar.
72 hours	1.25 times A
7 days	1.10 times A
28 days	1.00 times A

Where "A" is the strength of 1:3 standard Ottawa sand mortar specimens of same form and size made by the same operator using the same cement and the same amount of water.

The tests shall be made on mortars composed of 1 (one) part Portland cement and 3 (three) parts of fine aggregate or standard Ottawa sand, by weight. The test specimens shall be made, stored and tested in the same manner, under approved laboratory conditions and according to recognized standards of practice. Each value shall be the average from tests of no fewer than 3 (three) specimens.

Cement.

3-3.—The cement used in all tests shall meet the requirements of the specifications for Portland cement of the Canadian Society of Civil Engineers, as revised in 1916.

Stone Screenings.

3-4.——Stone screenings from a hard, tough, durable rock may be used as fine aggregate by written permission of the engineer, and provided it meets the requirements of mortar strength.

Sand for Bituminous Construction.

3-5.—Sand for use in bituminous pavement construction shall consist of hard, tough, durable particles. It shall not contain more than 1 (one) per cent. of clay or loam. When dry not more than 8 (eight) per cent. shall be retained on a sieve having 8 (eight) meshes per lineal inch, and shall not vary more than 5 (five) per cent. from the following:

Screen mesh per lineal inch.	Percentage by weight retained.
8	10
30	20
50	27
80	20
100	15
200	7
	1
	100 Pass

Cushion Sand.

3-6.—Cushion sand shall be clean and sharp, and not more than 10 (ten) per cent. by weight shall be retained on an 8 (eight) mesh sieve. It shall not contain more than 10 (ten) per cent. by weight of clay or loam.

Grout Sand.

3-7.—Grout sand shall be clean, sharp, and well graded. Not more than 8 (eight) per cent. by weight shall be retained on a 20 (twenty) mesh sieve, and not more than 30 (thirty) per cent. on a 100 (one hundred) mesh sieve. It shall not contain more than 5 (five) per cent. of clay or loam.

Mortar made in the proportion of 1 (one) part of cement to 3 (three) parts of sand by weight shall show a tensile strength at least equal to 40 (forty) per cent. of a similar mortar made of standard Ottawa sand, mixed in the same proportions and stored and tested in the same manner.

APPENDIX III.

Tentative Specifications for Asphaltic Road Oils

General

Asphaltic oils shall be classed into three grades, each containing the minimum percentage by weight of asphalt, of 50 degrees penetration, as follows:—

Light oil shall not contain less than 40 per cent. asphalt.
Medium oil shall not contain less than 60 per cent. asphalt.
Heavy oil shall not contain less than 80 per cent. asphalt.

All oil, in addition to meeting the requirements of one of the above grades, shall have the following characteristics as determined in the laboratory. All tests shall be conducted according to the latest methods recommended by the American Society for Testing Materials.

The requirements are as follows:—

1. It shall be obtained by the refining of asphaltic or semi-asphaltic petroleum or by the combination of solid or semi-solid native asphalts with asphaltic petroleums or derivatives thereof, which melt on the application of heat.
2. The various hydrocarbons composing it shall be present in a homogeneous solution.
3. It shall be free from water and sediment.
4. It shall not contain acid nor sulphur in sufficiently large quantities to attack rubber or rubber compositions

Light Oil

Light oil shall have the following characteristics:—

1. It shall have a specific gravity of not less than 0.92 (Ninety-two one hundredths) at 77 degrees Fahrenheit (25 degrees C.).
2. When evaporated in an open vessel at a temperature between 450 and 500 degrees Fahrenheit until the residue remaining has a penetration (5 seconds, 77 degrees Fahrenheit, No. 2 needle, 100 grams) of 50 (fifty) degrees, the residue shall meet the following requirements.
   (a) It shall amount to not less than 40 (forty) per centum and not more than 50 (fifty) per centum of the original oil by weight.
   (b) It shall have a ductility at 77 degrees Fahrenheit of not less than 25 (twenty-five) centimetres (Dow mould).
   (c) It shall have a melting point of not more than 160 (one hundred and sixty) degrees Fahrenheit and not less than 130 (one hundred and thirty) degrees Fahrenheit when tested by the ball and ring method.
3. Fifty grams of the oil upon being maintained at a temperature of 325 degrees Fahrenheit for 5 hours in a cylindrical vessel 2¼ inches in diameter and 1½ inches deep shall not lose more than 25 (twenty-five) per centum nor less than 10 (ten) per centum by weight.
4. It shall be soluble at air temperature in pure carbon bisulphide to the extent of not less than 99.0 (ninety-nine) per centum.
5. It shall be soluble at air temperature in 76 degrees Beaume paraffine petroleum naphtha distilling between 140 and 190 degrees Fahrenheit to the extent of not less than 85 (eighty-five) per centum and not more than 95 (ninety-five) per centum.
6. It shall yield not more than 8 (eight) per centum by weight of fixed carbon on ignition.
7. It shall show a flash point of not less than 120 (one hundred and twenty) degrees Fahrenheit when tested in an open cup.
8. It shall not contain more than 5 (five) per centum by weight of paraffine scale.

Medium Oil.

Medium oil shall have the following characteristics:—

1. It shall have a specific gravity of not less than 0.94 (ninety-four one hundredths) at 77 degrees Fahrenheit.
2. When evaporated in an open vessel at a temperature between 450 and 500 degrees Fahrenheit until the residue has a penetration (5 sec., 77 degrees Fahrenheit, No. 2 needle, 100 grams) of 50 degrees, the residue shall meet the following requirements:—
   (a) It shall amount to not less than 60 (sixty) per centum and not more than 70 (seventy) per centum by weight of the original oil.
   (b) It shall have a ductility at 77 degrees Fahrenheit of not less than 25 centimetres (Dow mould).
   (c) It shall have a melting point of not more than 160 (one hundred and sixty) and not less than 130 (one hundred and thirty) degrees Fahrenheit, when tested by the ball and ring method.
3. Fifty grams of the oil upon being maintained at a temperature of 325 degrees Fahrenheit for 5 hours in a cylindrical dish 2¼ inches in diameter and 1½ inches deep, shall not lose more than 12 (twelve) per centum nor less than 7 (seven) per centum by weight.
4. It shall be soluble at air temperature in pure carbon bisulphide to the extent of not less than 99.0 (ninety-nine) per centum by weight.
5. (a) It shall be soluble at air temperature in 76 degrees Beaume paraffine petroleum naphtha to the extent of not less than 83 (eighty-three) per centum and not more than 90 (ninety) per centum.
   (b) When 20 c.c.'s of naphtha solution, obtained by treating 1 gram of oil with 100 c.c.'s of 76 degrees Beaume petroleum paraffine naphtha at air temperature, is evaporated upon a glass plate, the residue shall be adhesive and sticky, but not oily.
6. It shall yield between 8 (eight) per centum and 12 (twelve) per centum by weight of fixed carbon on ignition.
7. It shall show a flash point of not less than 150 (one hundred and fifty) degrees Fahrenheit when tested in an open cup.
8. It shall not contain more than 5 (five) per centum by weight of paraffine scale.

Heavy Oil

Heavy oil shall have the following characteristics:—

1. It shall have a specific gravity of not less than 0.96

(ninety-six one hundredths) at 77 degrees Fahrenheit (25 degrees Cent.).

2. When evaporated in an open vessel at a temperature between 450 and 500 degrees Fahrenheit until the residue has a penetration (5 seconds, 77 degrees Fahrenheit, No. 2 needle, 100 grams) of 50 (fifty) degrees the residue shall have the following requirements:—
   (a) It shall amount to not less than 80 (eighty) per centum by weight of the original oil.
   (b) It shall have a ductility at 77 degrees Fahrenheit of not less than 40 (forty) centimetres.
   (c) It shall have a melting point of not more than 160 (one hundred and sixty) and not less than 130 (one hundred and thirty) degrees Fahrenheit when tested by the ball and ring method.
3. Fifty grams of the oil upon being maintained at a uniform temperature of 325 degrees Fahrenheit for 5 hours in a cylindrical vessel 2¼ inches in diameter by 1½ inches deep, shall lose not more than 5 (five) per centum by weight.
4. It shall be soluble at air temperature in pure carbon bisulphide to the extent of not less than 99.0 (ninety-nine) per centum by weight.
5. (a) It shall be soluble at air temperature in 76 degrees Beaume paraffine petroleum naphtha to the extent not less than 75 (seventy-five) per centum and not more than 90 (ninety) per centum by weight.
   (b) When 20 c.c.'s of naphtha solution, obtained by treating 1 gram of oil with 100 c.c.'s of 76 degrees Beaume petroleum paraffine naphtha at air temperature, is evaporated upon a glass plate, the residue shall be adhesive and sticky but not oily.
6. It shall yield between 8 (eight) per centum and 14 (fourteen) per centum by weight of fixed carbon on ignition.
7. It shall have a flash point of not less than 290 degrees Fahrenheit when tested in an open cup.
8. It shall not contain more than 5 (five) per centum by weight of paraffine scale.

Members of Committee

W. A. McLean, Chairman, W. P. Brereton, F. W. Doane, J. Duchastel, J. E. Griffith, G. Henry, E. A. James, A. F. Macallum, A. J. McPherson, P. Mercier, W. P. Near, G. C. Powell, C. H. Rust.

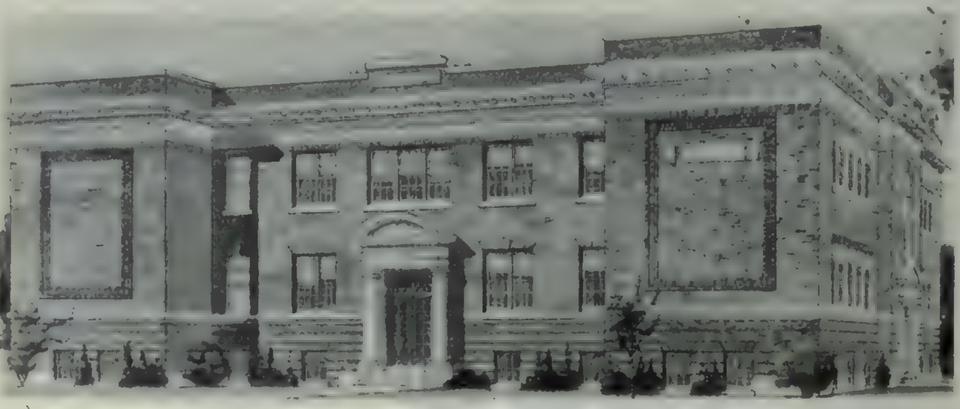
Union School at Brighton, Ont.

We reproduce herewith a perspective of a new union school which has recently been completed at Brighton, Ont., for the accommodation of both high school and public school scholars. It is a two-storey and basement structure and is suitably located in extensive school grounds donated for the purpose. It contains 11 classrooms, 5 of which are given over to the high school students. The building is 120 feet long and has two wings 80 feet wide, while the centre portion is 64 feet wide. On the ground floor there are 5 classrooms, a library and two principals' rooms for the principals of the high school and public school. The library is on the right of the main entrance, which faces south, and the principals' rooms are on the left. Besides the main entrance there are four exits from the building, two in the rear, and one at each end connected by a corridor which runs the entire length of the building. The classroom in the centre portion of the building, to the rear of the principals' rooms and library, may be extended to form an auditorium by removing the partitions separating it from this central corridor and corridors on either side leading to the rear exits. The eastern section of the building accommodates the high school and the western portion is given over to the public school, the two sections being kept separate. On the second floor there are six classrooms, including a science and apparatus room. The basement contains separate play rooms and toilets for the high and public school students; also boiler and coal rooms.

The building is of Denison interlocking tile construction faced with Suntex brick, which is somewhat unusual in schools of this type. The foundations are of concrete. Stone trimmings have been used and a galvanized iron cornice, while the entrances are of artificial stone. The basement is finished in concrete and painted. Yellow pine has been used for the interior finish of the school. The floors are of joist construction, 2 x 14 in., and are finished with hardwood. Five-ply felt composition roofing has been employed. The building is steam heated, two Kewanee firebox boilers being used, with a forced ventilation system employing a No. 7 type M. conoidal fan, driven by a Wagner motor.

The school is well equipped. There are separate

(Concluded on page 66)



Architect's perspective of new Union School at Brighton, Ont.

Building Code for Flat Slabs for What is Known as Four-way Type of Construction

By W. W. Pearse, C. E.*

Toronto, December 27th, 1916.

Editor Contract Record:—

Following up the discussion which I had with you with reference to this Department allowing the Chicago Building Code to be used in the city of Toronto for a four-way system of flat slab construction (which type of construction is not covered by the present Toronto By-law), I am enclosing herewith a brief analysis which I made in order to convince myself that the Chicago Code was based on good sound reasoning.

By an examination of this analysis you will note that apparently the Chicago Code is based on the theory of a beam of uniform section rigidly fixed at both ends. The negative bending moment for the full width of the panel over the supports would then be $-WL/12$, and the positive bending moment for the full width of the panel midway between the supports, $WL/24$. Assuming there were two continuous beams of width L running at right angles to each other, each carrying one-half the total live and dead loads, the individual moment over the support being $-WL/24$ and at the centre a positive moment of $WL/48$. This can readily be proved by adding together $WL/120$ and $WL/30$, the moments for the ½ panel strips called for in the Chicago Code, which sum equals $WL/24$, and also by adding together the centre positive moments $WL/80$ and $WL/120$, which sum equals $WL/48$. The problem then resolves itself into determining what proportions of $WL/24$ and $WL/48$ is taken by the centre and side strips.

In the analysis which I have submitted I have endeavored to arrive at an approximate method, which agrees in a surprising degree with what has been adopted in the Chicago Code. I have assumed that the line of contra-flexure around the centre of the panel is a circle, whereas actually from experiments on a rubber slab conducted by Mr. F. J. Trelease, it is an average between a square and a circle. I have also found this to be true by a number of tests on actual structures. However, for ease in figuring I have taken the circle as a basis, and by checking a number of cases I have found that it makes very little difference to the calculations. It would appear that the Chicago Code does not take into consideration Poisson's ratio, nor does it seem to make any allowance for arch action or tension in the concrete. This, of course, gives an additional factor of safety, and from tests which have recently been conducted in Toronto by Mr. Mylrea of the City Architect's Department, in conjunction with Prof. Gillespie, of the University of Toronto, the Chicago Code is undoubtedly quite conservative.

After looking over a large number of discussions on the flat slab type of construction, I was unable to find anything throwing any light upon how the Chicago Code was derived, and I am, therefore, not in a position to say whether my method is the same as was used by the Chicago experts in drafting their by-law, but at any rate, the results check, and my method is more or less based along theoretical lines.

In Table 1, I have endeavored to furnish information that may be useful for the architect or the engineer in designing this type of construction according to the Chicago Code. The dimensions given are those I believe to be the most economical. I have assumed that the concrete is stressed up to 700 lbs. per square inch and that the steel is stressed up to 18,000 lbs. per square inch, and due to the very satisfactory tests this department has conducted, I am prepared to allow these stresses in the future for this method of design. This table may be used for what is known as the four-way system. The two-way system will probably require the table to be considerably modified.

(Signed) W. W. Pearse,
City Architect and Supt. of Buildings.

Outline of Chicago By-law

In Fig. 1.

W = total panel load (live and dead) = wL^2 for square panel.

L = span in feet.

B = width of direct band = $L/2$

D = width of centre band = $L/2$

Referring to Fig. 1 it will be noticed that the bending moment for the side strips half way between the column centres is $M_b = WL/80$ (Resisted by one direct band) ... (a)

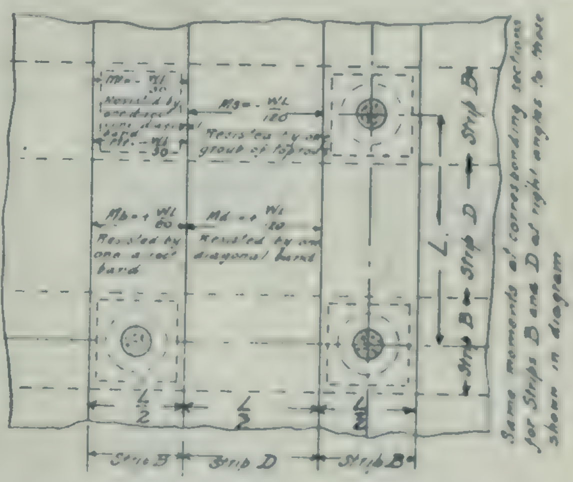

Mt = - WL/30
Resisted by one direct and one diagonal band
Ms = - WL/120
Resisted by one group of top rods
Mb = + WL/80
Resisted by one direct band
Md = + WL/120
Resisted by one diagonal band
L/2
L/2
L/2
L
Strip B
Strip D
Strip B
Strip B
Strip D
Strip B
Same moments at corresponding sections for Strips B and D at right angles to those shown in diagram

Fig. 1.—The strips are for design purpose only. The reinforcement is arranged as shown in Fig. 5.

Bending moment for the centre strip half way between the column centres is

$M_d = WL/120$ (Resisted by one diagonal band) ... (b)

Bending moment for the side strips over the column cap is

$M_t = -WL/30$ (Resisted by one direct and one diagonal band) ... ... (c)

Bending moment for the centre strip along the column centres is

$M_s = -WL/120$ (Resisted by top rods) ... (d)

For wall panels, the moments are as follows:—

Slab supported by wall columns. (Moments increased approximately by 20 per cent.)

$M_{bw} = WL/66$ (Resisted by one direct band) ... (e)

$M_{dw} = WL/100$ (Resisted by one diagonal band) ... (f)

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*City Architect and Superintendent of Buildings, Toronto.

$Mtw = -WL/24$ (Resisted by one diagonal band and one direct band) … … … … … … … … … (g)
$Msw = -WL/100$ (Resisted by top rods) … … … .(h)

For wall panels, the moments are as follows:

Slab supported on brick walls. (Moments increased approximately by 50 per cent.).

$Mbw = WL/54$ (Resisted by one direct band) … … … (i)
$Mdw = WL/80$ (Resisted by one diagonal band) … … (j)
$Mtw = -WL/20$ (Resisted by one diagonal band and one direct band) … … … … … … … … (k)
$Msw = -WL/80$ (Resisted by top rods) … … … … (l)

Rectangular Panels

When the sides do not vary in length more than five per cent., then the average length may be taken and panels figured as square.

For the four way system of reinforcement the amount of steel found for the positive moment of each strip D by designing in this manner shall be that used in the diagonal band. For the positive moment in each strip B, the required amount of steel in the crossband shall be obtained by multiplying the steel used in the design of the assumed square panel by the cube of the ratio found by dividing the length or breadth of the rectangular panel by the side of the assumed square panel, for the long and short sides of the panel, respectively. The compressive stresses shall be calculated on the basis of a width equal to one-half (½) of the side of the assumed square panel, and on the assumptions used in the calculations of compressive stress in square panels. In no case shall the amount of steel in the short side be less than two-thirds (2/3) of that required for the long side.

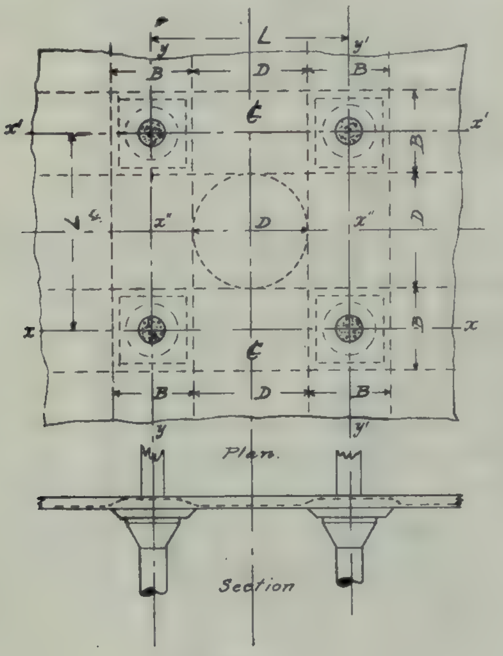


Fig. 2

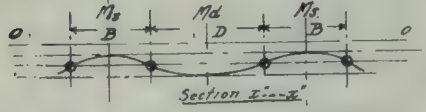


Fig. 3.—M = bending moment in inch lbs. $= 112\ bt^2$ when S is 18000 and C is 700 for ¾ per cent. of steel

Analysis of Chicago By-Law

Referring to Fig. 2 and assuming the slab to be cut along y….y and y'….y', making a continuous beam of width L and to be rigidly fixed at each end, of uniform section and loaded with a uniformly distributed load of "w" lbs. per square foot (this includes live and dead load) then $W = wL^2$.

Let Mr = bending moment in foot lbs. at point of support for entire width of slab.

Let Mc = bending moment in foot lbs. at centre of panel for entire width of slab.

Then $Mr = -WL/12$ … … … … … … … … … … (1)
and $Mc = +WL/24$ … … … … … … … … … … (2)

It is evident that the same conditions exist if the plate is cut along x'….x' and x….x and the ends rigidly fixed.

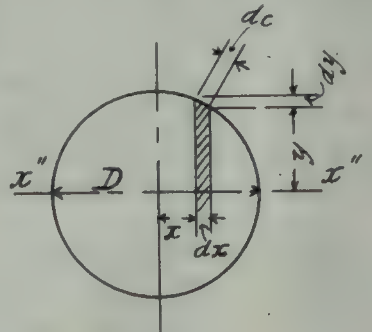


Fig. 4

Therefore equation (1) becomes $Mr = -WL/24$ … … (3)
(across axis x'….x' and x….x)
and equation (2) becomes $Mc = +WL/48$ … … … (4)
(across axis x"….x")

Let L = span centre to centre of columns in feet.
Let B = width of side strips in feet.
Let D = width of centre panel in feet.
Let W = total panel load (live and dead) $= wL^2$ for sq. panel.

Referring to Fig. 2, it is evident that the centre panel D will have a tendency to sag down in the centre, and any section taken through the centre would be bent into a parabola or the centre part would be approximately a parabolic surface of revolution.

If the centre circular part is assumed to be taken out and the bending moment is found (see Fig. 4) we get the following:

Let w = load per square unit (live and dead)
and w' = load per lineal unit of circumference.

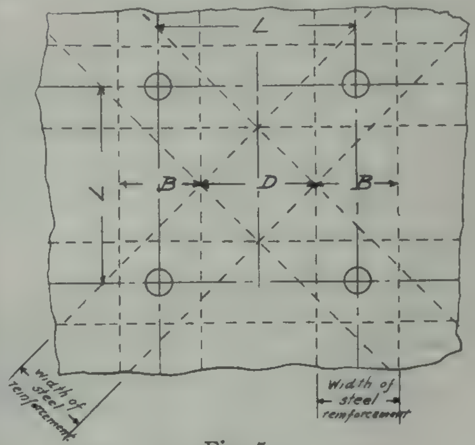


Fig. 5

Then $w' = rw/2$ … … … … … … … … … … (5)

Then the differential bending moment of one strip of width dx would be

$dm = (rw/2)y.\ dc - (w/2)y^2.\ dx$ … … … … … … (6)

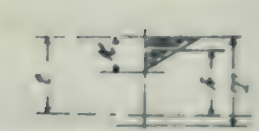
Substituting for dc and y in terms of x, equation (6) reduces to

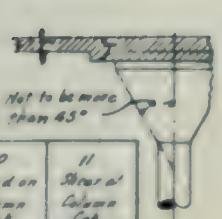
$dm = (w/2)\ x^2\ dx$ … … … … … … … … … … (7)

$$\text{and } Md/2 = (w/2)\int_0^r x^2\,dx = (w/2)r^3/3 = wr^3/6$$

Maximum allowable steel stress 18000 lbs. per sq inch.
Maximum extreme fibre stress concrete 700 lbs per sq inch.
Note - This Table is for Four Way Type of Construction only

TABLE I.





1	2	3	4	5	6	7 Slab Thickness						8	9 Steel in sq inches in each strip				10	11
Safe Live Load Lbs per sq ft	Side of Square Panel	Total load on one panel	Diam of Column Cap	Area of Column Cap. Sq feet	Side of Square Depression	Through Depression Inches		Slab for Strip B Inches		Slab for Strip D inches		Average dead weight of slab	One side Strip B	One diag Strip D	Short rods at top	Total in one diag. & one side strip Cap	Load on Column Cap	Shear at Column Cap
		W				T	h	T'	h'	T"	h"	Lbs	M. W/10	M. W/10	M. W/10	M W/10	Wc	W-Wc
40	16'-0"	30800	3'-8"	9.0	5'-4	9.5	7.04	6.0	4.4	6.0	4.0	80.2	.93	.69	.69	1.33	1386	29400
100	"	46000	"	"	"	9.5	7.04	6.0	4.4	6.0	4.0	80.2	1.4	1.02	1.02	2.32	1940	44100
125	"	52500	"	"	"	9.5	7.04	6.0	4.4	6.0	4.0	80.2	1.39	1.17	1.17	2.66	2150	50300
150	"	58800	"	"	"	9.5	7.04	6.0	4.4	6.0	4.0	80.2	1.78	1.3	1.3	2.97	2480	56300
200	"	73300	"	"	"	10.5	7.92	6.5	4.84	6.5	4.34	86.4	2.02	1.5	1.5	3.3	2900	70400
250	"	88000	"	"	"	11.5	8.8	7.0	5.28	7.0	4.78	93.5	2.22	1.63	1.63	3.56	3300	84700
300	"	104000	"	"	"	12.5	9.66	7.5	5.72	7.5	5.22	100.5	2.44	1.78	1.78	3.82	4000	100000
40	17'-0"	39800	4'-0"	11.2	5'-8"	9.5	7.04	6.0	4.4	6.0	4.0	80.2	1.17	.95	.95	2.14	1730	38100
100	"	54000	"	"	"	10.0	7.5	6.5	4.84	6.5	4.34	85.6	1.54	1.15	1.15	2.72	2430	51600
125	"	61000	"	"	"	10.0	7.5	6.5	4.84	6.5	4.34	85.6	1.79	1.3	1.3	3.08	2700	58300
150	"	68400	"	"	"	10.0	7.5	6.5	4.84	6.5	4.34	85.6	2.0	1.45	1.45	3.42	3000	65400
200	"	83000	"	"	"	10.5	7.92	6.5	4.84	6.5	4.34	85.6	2.42	1.77	1.77	3.96	3600	79400
250	"	100000	"	"	"	11.5	8.8	7.25	5.5	7.25	5.0	96.0	2.58	1.85	1.85	4.3	4300	95700
300	"	118000	"	"	"	13.0	9.9	8.0	6.16	8.0	5.66	106.5	2.72	1.95	1.95	4.5	5050	113000
40	18'-0"	40000	4'-2"	13.2	6'-0"	9.75	7.26	6.25	4.62	6.25	4.12	82.5	1.3	.95	.95	2.21	2040	38000
100	"	62500	"	"	"	11.0	8.36	7.0	5.78	7.0	5.28	92.7	1.62	1.16	1.16	2.99	3000	60000
125	"	70800	"	"	"	11.0	8.36	7.0	5.78	7.0	5.28	92.7	1.84	1.33	1.33	3.4	3340	67500
150	"	79000	"	"	"	11.5	8.8	7.0	5.78	7.0	5.28	93.3	2.05	1.46	1.46	3.6	3750	75200
200	"	95000	"	"	"	11.5	8.8	7.0	5.78	7.0	5.28	93.3	2.46	1.76	1.76	4.32	4400	90600
250	"	115500	"	"	"	12.5	9.66	8.0	6.16	8.0	5.66	105.8	2.83	2.02	2.02	4.8	5220	110300
300	"	134000	"	"	"	13.5	10.12	8.5	6.6	8.5	6.1	111.2	3.05	2.18	2.18	5.3	6000	128000
40	19'-0"	45500	4'-4"	14.2	6'-3"	10.0	7.5	6.5	4.84	6.5	4.34	85.7	1.48	1.1	1.1	2.57	2240	43300
100	"	71000	"	"	"	11.0	8.36	7.25	5.5	7.25	5.0	95.5	2.05	1.5	1.5	3.6	3240	67800
125	"	80000	"	"	"	11.0	8.36	7.25	5.5	7.25	5.0	95.5	2.30	1.68	1.68	4.05	3600	76400
150	"	89000	"	"	"	11.0	8.36	7.25	5.5	7.25	5.0	95.5	2.56	1.88	1.88	4.5	3940	85100
200	"	108000	"	"	"	11.5	8.8	7.5	5.72	7.5	5.22	99.4	2.98	2.18	2.18	5.2	4250	103800
250	"	130600	"	"	"	13.5	10.12	8.5	6.6	8.5	6.1	112.7	3.14	2.26	2.26	5.44	5800	124800
300	"	153000	"	"	"	14.0	10.56	9.0	7.04	9.0	6.54	118.7	3.44	2.46	2.46	6.12	6560	146400
40	20'-0"	53000	4'-6"	16.0	6'-8"	11.25	8.58	7.0	5.28	7.0	4.78	92.5	1.68	1.23	1.23	2.75	2740	50300
100	"	80000	"	"	"	12.0	9.24	7.5	5.72	7.5	5.22	100.0	2.34	1.71	1.71	3.85	3850	76100
125	"	90000	"	"	"	12.0	9.24	7.5	5.72	7.5	5.22	100.0	2.62	1.92	1.92	4.35	4250	85700
150	"	100000	"	"	"	12.0	9.24	7.5	5.72	7.5	5.22	100.0	2.93	2.13	2.13	4.82	4650	95300
200	"	124000	"	"	"	12.5	9.66	8.0	6.16	8.0	5.66	106.0	3.36	2.44	2.44	5.75	5500	118500
250	"	147000	"	"	"	14.0	10.36	9.0	7.04	9.0	6.54	118.6	3.49	2.51	2.51	6.32	6600	140400
300	"	170000	"	"	"	15.0	11.44	9.5	7.48	9.5	6.98	126.2	3.80	2.7	2.7	6.6	7600	162400
40	21'-0"	60000	4'-9"	17.7	6'-10"	11.5	8.8	7.25	5.5	7.25	5.0	95.0	1.92	1.4	1.4	3.19	3080	56900
100	"	91000	"	"	"	12.5	9.66	8.0	6.16	8.0	5.66	106.0	2.59	1.88	1.88	4.4	4350	86600
125	"	102000	"	"	"	12.5	9.66	8.0	6.16	8.0	5.66	106.0	2.91	2.1	2.1	4.95	4800	97200
150	"	113000	"	"	"	12.5	9.66	8.0	6.16	8.0	5.66	106.0	3.22	2.32	2.32	5.49	5250	107700
200	"	138000	"	"	"	13.5	10.12	8.5	6.6	8.5	6.0	112.0	3.66	2.65	2.65	6.38	6350	131600
250	"	167000	"	"	"	15.0	11.44	9.5	7.48	9.5	7.0	126.0	3.91	2.79	2.79	6.8	7500	159500
300	"	191000	"	"	"	16.0	12.32	10.0	7.92	10.0	7.42	132.8	4.25	3.0	3.0	7.22	8650	182300
40	22'-0"	67600	5'-0"	19.0	7'-3"	12.0	9.24	7.5	5.72	7.5	5.22	100.0	2.17	1.6	1.6	3.58	3400	64200
100	"	103000	"	"	"	13.5	10.12	8.5	6.6	8.5	6.1	113.7	2.66	2.06	2.06	5.0	4900	98100
125	"	115000	"	"	"	13.5	10.12	8.5	6.6	8.5	6.1	113.7	3.19	2.3	2.3	5.56	5360	109600
150	"	127000	"	"	"	13.5	10.12	8.5	6.6	8.5	6.1	113.7	3.52	2.54	2.54	6.15	5850	121100
200	"	157000	"	"	"	14.0	10.56	9.0	7.04	9.0	6.54	118.7	4.0	2.88	2.88	7.15	6900	150100
250	"	186000	"	"	"	16.0	12.32	10.0	7.92	10.0	7.42	133.0	4.35	3.04	3.04	7.4	8300	177700
300	"	213000	"	"	"	17.0	13.2	10.5	8.36	10.5	7.86	140.7	4.7	3.32	3.32	7.95	9500	203500
40	23'-0"	74500	5'-3"	21.2	7'-8"	12.5	9.66	8.0	6.16	8.0	5.66	106.0	2.42	1.78	1.78	4.1	3960	70500
100	"	114500	"	"	"	13.75	10.34	8.75	6.82	8.75	6.32	115.6	3.23	2.32	2.32	5.65	5500	109000
125	"	127500	"	"	"	14.25	10.78	8.75	6.82	8.75	6.32	115.6	3.58	2.59	2.59	6.05	6150	121300
150	"	141000	"	"	"	14.25	10.78	8.75	6.82	8.75	6.32	115.6	3.96	2.86	2.86	6.7	6700	134300
200	"	173000	"	"	"	15.0	11.44	9.5	7.48	9.5	7.0	126.2	4.42	3.15	3.15	7.7	8000	165000
250	"	206000	"	"	"	17.0	13.2	10.5	8.36	10.5	7.86	140.6	4.7	3.36	3.36	7.95	9500	196500
300	"	234000	"	"	"	17.75	13.86	11.0	8.8	11.0	8.3	146.5	5.15	3.66	3.66	8.75	10700	223300
40	24'-0"	86500	5'-6"	23.4	8'-0"	13.5	10.12	8.25	6.38	8.25	5.88	109.0	2.7	1.94	1.94	4.55	4600	81900
100	"	126000	"	"	"	14.5	11.0	9.0	7.04	9.0	6.54	119.2	3.56	2.56	2.56	6.1	6300	120000
125	"	141000	"	"	"	14.5	11.0	9.0	7.04	9.0	6.54	119.2	4.0	2.87	2.87	6.82	6900	134000
150	"	155000	"	"	"	14.5	11.0	9.0	7.04	9.0	6.54	119.2	4.4	3.16	3.16	7.5	7650	147500
200	"	192000	"	"	"	16.5	12.76	10.0	7.92	10.0	7.42	133.6	4.85	3.45	3.45	8.0	9350	183000
250	"	228000	"	"	"	17.5	13.64	11.0	8.8	11.0	8.3	146.6	5.17	3.66	3.66	8.9	10600	217400
300	"	261000	"	"	"	19.0	14.96	11.5	9.24	11.5	8.76	154.0	5.65	4.0	4.0	9.3	12300	249000

Table 1 of Mr. W. W. Pearse's paper giving standard figures for four-way concrete slab construction

or $Md = wr^3/3$ = bending moment across axis $x'' \ldots x''$ (8)
But $r = D/2$
Therefore $Md = wD^3/24$ ... ... (9)

Referring to Fig. 5, and the conditions shown, then

$B = .414L$ ... ... (10)
$D = .586L$ ... ... (11)
$D^3 = .2L^3$ ... ... (12)

Substitute value found in equation (12) for D^3 in equation (9) then

$Md = + wL^3/120$ ... ... (13)
But $W = wL^2$, substitute in equation (13)
$Md = + WL/120$ ... ... (14)

The bending moment given in equation (14) is resisted by one diagonal band, and it is the same as given by the Chicago By-law, see equation (b).

By referring to equation (4) it will be noticed that the total bending moment across axis $x'' \ldots x''$ is $Mc = + WL/48$ and it was just found by equation (14) that the bending moment for the centre panel is $Md = + WL/120$.

Therefore $Mb = Mc - Md = WL/48 - WL/120$
$= + WL/80$ ... ... (15)
or $Mb = + WL/80$ = bending moment in side panels and is resisted by one side panel B. This is the same as the Chicago By-law, see equation (a).

Referring to equation (3)

$Mr = - WL/24$.
Let w = load per square foot.
p = load per unit length of the line of contraflexure.
q = load per unit length of line of column cap.
Mt = bending moment across axis $x \ldots x$. (See Fig. VI.)

Fig. VI. shows the approximate line of contraflexure around column centre. It is not a circle but most authorities assume it to be so.

The approximate bending moment may be found across axis $x \ldots x$ as follows, and is what is given for Mt, see equation (c).

If a differential strip is assumed of a width of dx, then

$dm = p.dc.y + w.y.dx.y/2 - q.ds.v$
$- w.v.dx.v/2$ ... ... (16)

Substituting the following values and then integrating,

$y = \sqrt{R^2 - x^2}$
$dc = Rdx/y$
$ds = rdx/v$
Then

$$Mt/2 = p\,R\int_0^R dx + w/2.R^2\int_0^R dx - w/2\int_0^R x^2\,dx$$

$$- qr\int_0^r dx - w/2.r^2\int_0^r dx + w/2\int_0^r x^2\,dx \quad \ldots \ldots \ldots (17)$$

$Mt/2 = pR^2 + w/2.R^3 - w/6.R^3 - qr^2 - w/2.r^3 + w/6.r^3$ ... ... (18)

Substituting following values in equation (18).

$$p = \frac{wL^2 - w\pi R^2}{2\pi R}$$

$$q = \frac{wL^2 - w\pi r^2}{2\pi r}$$

$R = L/4$
$r = L/8$ approximately.
Then equation (18) becomes
$Mt/2 = 57\ w\ L^3$
or $Mt = 28.5\ w\ L^3$ ... ... (19)
but $W = wL^2$
then $Mt = 28.5\ WL$ (Resisted by one diagonal band and one straight band) ... ... (20)

Referring to equation (c) it will be noticed that the Chicago Code gives Mt as $- WL/30$, which is very nearly the same as is given by equation (20).

But $Mr = - WL/24$ = total moment for the full width of the slab along column centres and taking
$Mt = - WL/30$, then $Ms = Mr - Mt$.
Therefore $Ms = - WL/24 + WL/30 = - WL/120$ .. (21)

Ms is resisted by short rods at top of concrete slab.

This is verified by Trealease in his experiments on a rubber slab as he found that
$Ms = Md$ which was found to be $WL/120$, see equation (14)

Shearing Stresses Allowed by the Chicago Code

The allowable unit punching shear on the perimeter of the column capital shall be three-fiftieths (3/50) of the ultimate compressive strength of the concrete as given in section 546 of the building ordinance. The allowable unit shear on the perimeter of the drop panel shall be three one-hundredths (3/100) of the ultimate compressive strength of the concrete. In computing shearing stress for the purpose of determining the resistance to diagonal tension the method specified by the ordinance shall be used.

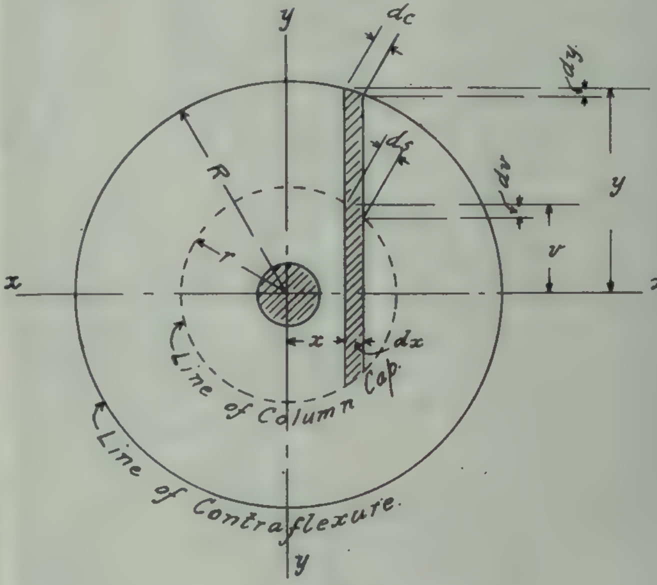


Fig. 6

Mixture	Ultimate Compressive Strength per sq. in.
1 cement, 1 sand, 2 broken stone, gravel or slag.	2900
1 cement, 1½ sand, 3 broken stone, gravel or slag	2400
1 cement, 2 sand, 4 broken stone, gravel or slag	2000
1 cement, 2½ sand, 5 broken stone, gravel or slag	1750
1 cement, 3 sand, 7 broken stone, gravel or slag	1500

Annual Meeting Toronto Section C.S.C.E.

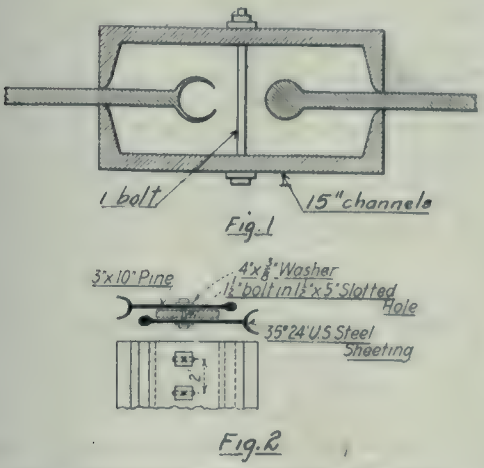
The Toronto branch of the Canadian Society of Civil Engineers held their annual meeting for the election of officers for the ensuing year on Thursday, January 11, at the Engineers' Club rooms. Reports of the various committees were also considered and disposed of. A suggestion was offered that some effort be made to bring the members of this branch into more intimate acquaintanceship with one another, and to this end a social sub-committee will probably be formed in the near future to look into the matter. Following are the officers for 1917: Chairman, E. W. Oliver; secretary-treasurer, L. M. Arkley; executive, G. A. McCarthy, A. H. Harkness, T. T. Black, H. G. Acres, and E. G. Hewson. Mr. G. A. McCarthy, the retiring chairman, was confirmed in his appointment as representative of the Toronto branch C.S.C.E. on the Joint Committee of Technical Associations.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Special Devices Secure Closure in Sheet Pile Walls

Closing a single wall steel cofferdam is frequently a troublesome procedure. In a number of cases a space remains which cannot be closed with a single pile, and in some instances the opening is wedge-shaped, making closure more difficult. Ordinary means cannot be used, either when sheeting comes together bell to bell or socket to socket. The accompanying sketches illustrate two methods that were devised in two particular instances to secure closure in cases where cofferdams did not close.



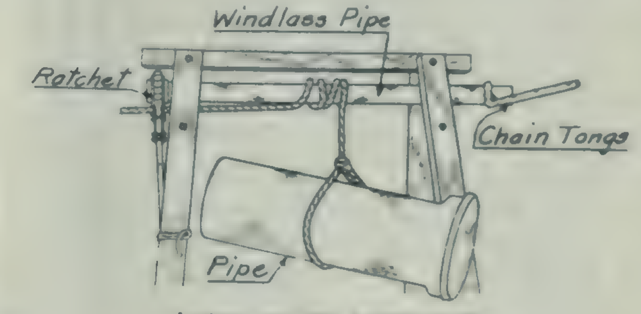
Two methods of closing steel sheet pile cofferdam.

Fig. 1 shows a closure joint for a dam consisting of steel piles driven to bed rock and in which a wedge-shaped opening remained which was 32 feet in depth and tapered from 13 inches at the bottom to practically nothing on top. At first an attempt was made to close the dam by driving a key pile, but this was torn out at a depth of about 15 feet. The method of overcoming the difficulty was to bolt two 15-inch channels together, as shown, flange to flange, with 1-inch bolts, and drive them with the flanges fitting snugly against the webs of the sheet piles. As this special pile was driven and each bolt reached the water line it was tightened. The opening was closed and the joint made watertight by this method.

Fig. 2 is a diagram of a special closure pile devised for a case where sheeting came together ball to ball in a wedge-shaped opening in about 15 feet of water. Two 35 lb., 24 ft. U. S. Steel sheet piles were lightly bolted together as indicated, using a 3 in. x 10 in. pine filler between them. The 1½ in. bolts were inserted in 1½ in. x 5 in. slotted holes, spaced 2 ft. apart. Square washers 4 in. x ⅜ in. were used. All parts were well greased and the pile was driven, all nuts being placed on the inside of the dam. The slotted holes enabled the pile to accommodate itself to the opening and after it was driven, bolts were tightened from the inside as pumping and excavation proceeded. This arrangement made a very effective closure. To cut the slotted holes in the piles, three 1½ in. holes were drilled and the material between cut away with a cold chisel.

A Pipe-Laying Trestle

A pipe-laying appliance to replace the usual three or four-legged tripod was described in a paper presented to the Pacific Coast Gas Association by G. E. Keppelmann and which is illustrated in the sketch here with. The apparatus consists of a wooden trestle supporting a windlass pipe turning on wooden bearings by means of common pipe chain tongs operated by one man at one end of the pipe. At the other end a ratchet is screwed to the pipe and fastened to one leg of the trestle, to prevent any reverse motion in the pipe. The pipe to be laid is rolled or skidded over the trench, a rope is fastened to it, and the free end is wrapped four times around the windlass pipe. One man handles the chain tongs and another takes in the slack rope, while the ratchet takes care of any slip. The skids are removed when they are cleared, and the pipe is lowered by one man easing up on the rope, care being taken to avoid surges that might break the rope. Any pipe up to 16 in. in diameter can be laid in this way. It is customary when using this appliance to fasten the rope a little to one side of the centre toward the bell, and on being lowered the spigot end is depressed to clear any dirt that may have lodged in the pipe.



Laying a pipe with a special trestle.

Wood Studs Support Tank Reinforcing

In building reinforced concrete tanks of a circular type, there is considerable difficulty in placing the horizontal steel, especially with thin walls. The trouble can be overcome by using vertical 2 in. by 4 in. studs with spikes driven at proper intervals which serve to support the horizontal reinforcing in exact position until this steel can be wired securely to the vertical rods. The method of use is to build the outside forms and set the vertical steel. Then around the outside of the circle to which the horizontal reinforcing is set, a number of studs are stood with the heads of the spikes projecting inwards. The studs are secured to the outside form so that when the rods are placed on the spikes and against the studs, they are at the proper distance from the outer surface of the wall. After this reinforcing is properly secured to the vertical rods the spikes are withdrawn and the 2 x 4's removed. By using this device the steel is erected as a stiff structure in correct position before it is required to carry its own weight.

Hydrated Lime Produces Beneficial Results and Overcomes Difficulties

THE Hydrated Lime Bureau recently offered prizes for short letters describing actual instances where hydrated lime was used and found to be of value. The results of the contest, as recently announced, awarded the first prize to H. T. Whitney, engineer in charge of bridge construction for the Indianapolis and Frankfort Railroad. His letter describes the beneficial effects that followed the addition of hydrated lime to concrete for bridge work that is being carried out by the Pennsylvania lines on an extension of their road. Excerpts from this letter are given herewith:

"These bridges include box culverts, spans 10 to 20 ft.; flat-top subways, two sidewalk spans of 12 ft., and street span of 32 ft.; arch spans, 30 to 50 ft.; one arch bridge of three spans, 65 ft. each; one arch bridge of two spans, 55 ft. each—a total of 42 bridges of various types.

"With the exception of the small culverts most of the bridges contain from 1,000 to 1,600 cubic yards of concrete. The concrete for all the structures of any size is being handled by means of a tower. About ten of these are located at public highways, where a good supply of water could not be obtained except at a considerable expense. The use of hydrated lime enables us to cut down the water and still have concrete flow freely in the spouts.

"Several of the flat-top subways are complicated skew spans, with numerous corners. The lime has proved very successful in these structures, as it prevented honeycombing and gave a smooth face in parts of the structures that we could not reach to spade. The cost of spading is reduced 50 per cent. by the use of lime.

"The lime makes the concrete more dense and more easily handled after it is deposited in the forms. It is frequently necessary to move a batch to some other part of the form when it has been deposited in the wrong place by the chute. The labor cost for this kind of work has been reduced about 40 per cent. by the addition of lime.

"On bridges where the reinforcing is closely spaced the lime is of great assistance, because it enables us not only to place the concrete easily, but it also prevents the separation of the aggregate when the mixture is being forced between and under the bars with wooden paddles.

"Because of the reduction of water in the mixture there is very little rough material deposited on the face, such as will occur when the mixture is very wet and the water seeps through the forms. This feature, together with the material reduction in honeycombing, has reduced the cost of finishing the face after the forms are taken off."

Other writers also cited cases where hydrated lime proved to be of immense value and where its use overcame difficulties and produced beneficial results. In one instance this material overcame trouble imposed by a poor quality of sand and a coraline limestone. The best local sand was not all that could be desired, being too fine and poorly graded as to size, while the coraline limestone used was very irregular in shape, with many cavities to be filled and projections to prevent smooth flowing. If enough water was added to make the concrete flow the mixture was too wet to give good strength, and there was trouble from the rock occasionally staying in the chutes while the mortar ran out. If the mix was dry enough to give good strength the concrete would not flow, and it required an excessive amount of working in the forms to cover the reinforcing and to give a good surface. At its best the concrete was inclined to be porous and absorb water. The climate was warm, with a damp, salt air, so that a dense waterproof concrete was required to prevent rusting of the reinforcing steel.

After considering the various waterproofing compounds on the market it was decided to try the use of hydrated lime to overcome the difficulties. Forty pounds of lime was used to each cubic yard of concrete, a very convenient proportion, as half a sack of lime was added to each three-sack batch of concrete. The lime seemed to lubricate the mixture so that with the addition of but a moderate amount of water it would easily flow down the chutes. There was no more trouble from the mortar and the stone separating or from the mixture being too stiff to flow. When in the forms it required little working to thoroughly cover the steel and to give a good surface. The particles of sand appeared to flow over each other easily, so that the resulting concrete was not nearly so porous and the steel was well protected from the corroding influence of the tropical salt air.

Union School at Brighton, Ont.

(Continued from page 60)

inter-communicating telephone systems for both sections throughout all rooms, and a fire alarm system has been installed. Natural slate blackboards have been provided throughout in the classrooms. The building is fitted with vacuum cleaning apparatus. A septic tank situated within the school grounds provides for the disposal of sewage.

The cost of the building was $50,000, and the contract was carried out by the Dickie Construction Company, Toronto. Messrs. Ellis & Ellis, Toronto, were the architects.

Personals

Mr. A. C. Garden has been elected chairman of the Hamilton Harbor Commission for 1917.

Mr. D. M. Mawhinney, formerly with the Winnipeg, Selkirk and Lake Winnipeg Railway, has been appointed engineer for Rockwood municipality, with offices at Stonewall, Man.

Lieut. Col. F. O. W. Loomis has been awarded the D.S.O. He was, prior to the war, a member of the Montreal contracting firm of D. C. Loomis & Sons. He went to the front with the first Canadian contingent, and is now with the headquarters staff in England.

Mr. W. W. Butler, vice-president of the Canadian Car & Foundry Company, Limited, Montreal, has been elected vice-president and managing director. Mr. W. S. Atwood, heretofore chief engineer and general works manager, has been appointed operating manager.

Lieut. C. Austin Bell, son of Chas. R. Bell, Sumach St., Toronto, has been awarded the Military Cross for bravery in action. Lieut. Bell is a graduate of the School of Practical Science, and before enlisting was employed as a mines maintenance engineer with the Canadian Copper Company. He was twice wounded, once at Langemarck and once at Ypres, but later returned to the front. He enlisted as a private in the Engineers and won his commission on the field.

Mr. John I. Reid, formerly works manager of the American Steel Foundries plant at Chester, Pa., and recently sales agent for that company at 30 Church Street, New York, has been appointed superintendent of the Longue Pointe plant of the Canadian Steel Foundries, Limited, Montreal.

Capt. A. Gerald Knight, who was recently announced as being awarded the D.S.O. and a few days ago also the M.C., is now reported missing. He was spoken of as Canada's premier aviator. Capt. Knight is a graduate of the Department of Applied Science and Engineering of the University of Toronto.

Major Lindsay Malcolm, A.M.Can.Soc.C.E., of the Canadian Engineers, who went overseas in command of an engineering company from Queen's University, Kingston, received honorable mention in the latest dispatch of Sir Douglas Haig. Major Malcolm was at one time acting city engineer at Guelph, Ont.

Lieut. Robert L. Dunsmore, of St. Thomas, Ont., who enlisted shortly after the declaration of war and went overseas with an engineering unit in the Second Division, has been awarded the Military Cross for bravery under fire. Lieut. Dunsmore was wounded last July. He is a civil engineer by profession and a graduate of Queen's University, Kingston, Ont.

Major E. G. M. Cape, president of E. G. M. Cape & Co., Ltd., contractors, Montreal, is mentioned in the recent despatches by Field Marshall Sir Douglas Haig. Major Cape commands the 106th Battery Canadian Heavy Siege Artillery, one of the finest batteries that ever left Canada. Major Cape, who is a B.Sc., was at one period lecturer on mechanical engineering at McGill University, and has also held positions with public companies. He is a member of the Canadian Society of Civil Engineers.

Mainly Constructional

East and West—From Coast to Coast

The Board of Works of Chatham, Ont., commenced operations recently on the laying of the new twelve-inch sewer along Tecumseh Road to the sugar factory.

It is stated that the big $1,000,000 bridge over the Peace River at Edmonton, for which tenders were recently called, is to be completed within 18 months; work on the substructure is planned to start early this month.

The public works' appropriation in St. John, N.B., for the year 1917 is $135,525.69, as compared with $111,550.19 last year. The increase over 1916 covers new asphaltic pavements.

Plans are being prepared for a new motion picture theatre in the city of Toronto, with a seating capacity of 2,500, to be erected at the corner of Richmond and Victoria Streets. Messrs. Hynes, Feldman & Watson, of Toronto, and S. H. Crane, of Detroit, are the architects. The building is also to include several stores and offices.

A proposal has been made to open up Pape Avenue, Toronto, from its present northerly terminus across the Don River and on into Leaside. This will entail the building of a bridge. The matter has received the attention of the Todmorden Ratepayers' Association and a committee was appointed to go over the district and report at a later meeting.

Tentative plans for the first unit of the new departmental store to be erected at the corner of Yonge and College Streets, Toronto, were submitted to City Architect Pearse recently. This building will be eight storeys high and the dimensions are 250 x 250 feet. Brick and steel will be the materials of construction. The city architect was asked to consider plans for the fire escapes on the first unit.

The new government dock that has been under construction at the foot of Salsbury Avenue, Vancouver, and at which grain will be loaded from the big elevator for transportation to Europe, has just recently been opened. The wharf is 800 feet in length by 300 feet in width, with a shed 700 feet long by 80 feet wide. On the west side, where the elevator is situated, seven railroad tracks are laid, it is also the intention to lay one on the east side.

On instructions by the Government, work on the contract for improving Courtenay Bay at St. John, N.B., has been discontinued. The contract was held by the Norton Griffiths Company of Canada, and work to the value of $3,000,000 has been carried out. It is understood that the progress expected to have been made has not materialized, and that the Government, in pursuance of their policy to postpone all possible public expenditure, decided that it was advisable, under the circumstances, to stop the work. A large dry dock was part of the scheme, which was planned by the Laurier Government.

Information has been given out by Mr. J. D. McArthur, president of the Edmonton, Dunvegan & British Columbia and allied railways, regarding the work on the new northern railways, to the effect that steel is being laid on the Alberta & Great Waterways Railway at the present time at the rate of one mile a day and that steel for the fifty-mile extension of the E., D. & B. C. mainline from Spirit River to Pouce Coupe has been purchased in the United States and will be laid early in the spring. The 1917 programme will include the ballasting of the only unballasted part of the main line of the E., D. & B. C., a distance of 17 miles east of Spirit River, the ballasting of the Grande Prairie branch, the ballasting of the main line extension from Spirit River to Pouce Coupe, and the ballasting of the A. & G. W. to McMurray.

The following are the nominations for 1917 of the nomination committee of the Montreal Builders' Exchange:—President, Mr. J. P. Anglin, of Anglins, Limited; 1st vice-president, Mr. W. C. Munn, Munn & Shea; 2nd vice-president, Mr. Robert F. Dykes, T. A. Morrison & Co.; past president, Mr. John Quinlan, J. Quinlan & Co.; directors, Messrs. Alex. W. Bremner, representing suppliers of builders' materials; Alex. Charette, master plumbers; Lawrence J. Conroy, Master Plumbers' Association of Montreal; Andrew Cross, Mantel and Tile Dealers' Association of Montreal; D. McCuaig, electrical contractors; T. H. Douglas, roofing contractors; W. M. Irving, general contractors; W. E. Potter, master painters; W. E. Ramsay, manufacturers of building materials; J. J. Roberts, carpenters and mill workers; J. E. Walsh, sanitary and heating engineers.

Last year saw the completion in Victoria, B.C., of the Northwest sewer. It was started on December 8, 1913, and finished on October 26 last, at a cost of $289,563, or $75,000 less than the estimate. Its length is 16,578 feet and of this, 7,449 feet is in tunnel, 6,390 feet of it through solid rock. Another municipal undertaking carried out during 1916 was the extension of the high pressure water system to take advantage of the additional pressure provided by the Sooke waterworks. The cost was $14,320, and the connection was made by a 12-inch cast-iron pipe. In addition to sewer extensions and the usual maintenance work, the city engineer's department has had to give considerable attention to Ross Bay seawall, which was severely damaged in the heavy storms of last winter. Very extensive alterations have been effected, and those improvements have to be protected by a toe of rock, similar to the new breakwater, this work now being in hand.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Chatham, Ont.

Work will be started early in the year on the laying of water mains from St. Clair Street to City Limits, 1,650 ft.; from City Limits to River Crossing, 1,111 ft., and from River Crossing to Jointing 300 ft. 12-inch vitrified tile. Clerk, J. C. Weir, Harrison Hall.

Exeter, Ont.

The Town Council plans to get estimate on cost of pavement to be laid on Main Street. Reeve, B. W. F. Beavers.

Hamilton, Ont.

The laying of a 700-ft. sewer to cost $4,000 is being considered by the City Council. Plans and specifications with the city engineer, E. R. Gray, City Hall.

London, Ont.

Asphalt pavements on Adelaide, Wellington, and Richmond Streets, to cost $60,000, are contemplated. Engineer, H. A. Brazier, City Hall.

Tenders will be called about Feb. 15th for the purchase of sewer pipes. Engineer, H. A. Brazier, City Hall, is preparing plans.

The Utilities Commission are considering the laying of new water mains in the spring and will be in the market shortly for cast iron piping. E. V. Buchanan, City Hall, general manager.

Tenders are to be called about February 15th for the laying of 30,000 sq. yds. of asphalt pavements.

Metcalfe, Ont.

A by-law has been submitted for the laying of cement sidewalks here. Engineer, F. Stidwell, C.E., Fifth Avenue, Cornwall, Ont.

Toronto, Ont.

Works Committee has requested Commissioner Harris to prepare report re addition of activated sludge unit to sewage disposal plant on Morley Avenue.

Works Commissioner R. C. Harris has recommended, at a cost of $20,500, a sewer on west side of Don Esplanade, from Eastern Avenue to Wilton Avenue. Secretary, T. McQueen.

The Ontario Railway and Municipal Board has approved of the by-laws prepared in connection with water supply to York Township, connecting with City of Toronto mains. Contracts for work not yet awarded. Engineer, Frank Barber, 57 Adelaide East.

Time for receiving tenders for the installation of a 40,000,000 imperial gallon centrifugal pump has been extended to January 30th. Plans, etc., at Room 6, City Hall. Secretary, T. McQueen

Railroads, Bridges and Wharves

Toronto, Ont.

The Todmorden Ratepayers' Association advocate the extension of Pape Ave. to Leaside and the erection of bridge over the Don River.

Winnipeg, Man.

The Transcona Electric Railway Company has made application for incorporation. Moran, Anderson & Guy, 402 Electric Railway Chambers, are solicitors. Work will start in the spring for line to be in operation in the fall.

CONTRACTS AWARDED

Hamilton, Ont.

The Ottawa Contracting Company, Ottawa, Ont., have been awarded the general contract for the building of a wharf to cost $4,500. The above work will be started as soon as ice is solid enough to hold machinery.

Public Buildings, Churches and Schools

Beloeil Village, Que.

The erection of a school to cost $12,000 is being considered. Secretary-Treasurer, J. P. M. Menard.

Chambly Village, Que.

The erection of a school to cost $3,000 is considered. Secretary-Treasurer, Geo. S. Wallis, Chambly Canton.

Fort William, Ont.

The by-law for the erection of a collegiate has been passed.

Glace Bay, Ont.

Plans for the erection of a school to cost $17,000 are nearly completed. Tenders will be called about January 20th. Secretary-Treasurer, Neil McNeil. Architect, Jos. H. Morley. Building will be of frame construction, concrete foundation.

Hamilton, Ont.

The City Council contemplate the erection of a pavilion of one storey, frame construction to cost $15,000.

The City Council are considering the erection of a number of buildings of one storey, frame construction, at Wobassa Park. Chairman of Parks Board, Geo. Wild, 559 Barton E.

Kitchener, Ont.

Chief Inspector Ross of the Post Office Department, has recommended the enlargement of the present Post Office; also addition to buildings at station.

Lennoxville, Que.

The general contractor, John Quinlan & Company, 4414 St. Catherine West, Montreal, will buy freight elevator and the commission will buy seating and desks for the new school to cost $235,000 which is being erected by the Bishop's School Corp. K. G. Rea, Beaver Hall Hill, Montreal, architect.

Montreal, Que.

The Quebec Legislature has authorized the Tres Saint Redemteur Congregation to raise money to build a church and presbytery to cost $200,000. Architect will be appointed.

Mt. Dennis, Ont.

School Section No. 28 contemplates adding two or three rooms to school building. Chairman, Jas. Syme.

Ottawa, Ont.

The erection of a school is being considered by the Public School Board, 222 Gilmour Street. Crawford Ross is secretary-treasurer.

The renovation of the Holy Trinity Church is contemplated. Rector, Rev. Robt. Jefferson.

Pembroke, Ont.

The School Board will purchase 150 single desks for the new school being erected to cost $50,000. Architect, W. C. Keighley, Grand Trunk Building. General contractor, H. P. Beck, 18 Woodlawn Avenue, Ottawa.

Pointe au Pic, Que.

Tenders are received to January 19 by Rev. J. B. Boivin for the erection of a church and presbytery; frame and brick construction. J. P. Ouellet, 28 St. Famille Street, Quebec, architect.

Quebec, Que.

The Roman Catholic School Board are considering the erection of an annex to the St. Joseph Academy. Secretary-treasurer, A. C. Taschereau.

St. Hyacinthe, Que.

In connection with the erection of a three-storey school, plastic brick construction, to cost $25,000, by the Roman Catholic School Commissioners, the probable general contractors will be Paquette & Godhout. Blackboards are included in general contract. Commission buys seating and desks.

St. Michel des Saints, Que.

Erection of a school to cost $3,000 is contemplated. Rev. J. O. Frechette, secretary-treasurer.

Sarnia, Ont.

The Board of Education are considering addition to Collegiate and to Confederation Street School. Geo. Proctor is chairman of the Building Committee.

Sydney Mines, N.S.

The erection of a school to cost about $20,000 is contemplated here. A. C. McCormick is chairman.

The Town Council are considering the erection of a fire hall and stable to cost $4,000. Work to start with stable portion first. Clerk, D. C. McDonald.

Vaudreuil, Que.

The erection of a school to cost $3,800 is contemplated here by the Dorion School Board. J. B. A. Favreau, N.P., is secretary-treasurer.

West Hill, Ont.

The erection of a new school is being considered by the Public School Section No. 7, Township of Scarboro. H. Westney, West Hill, Secretary.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **January 24, 1917** **No. 4**

Principal Contents

Page
Editorial 69
Interesting Erection Methods Employed at New Steel and Concrete Factory at Weston, Ont. 71
Modern Fireproof Construction 73
What Policy for 1917? 74
Causes of Cracks in Concrete Pavements 77
Residence Involving Unusual Features 81
Montreal City Engineer Replies to Report of Ratepaying Engineers Regarding the Aqueduct Scheme 83
Practical Hints for Contractors 86
Mainly Constructional 87

Legal Penalty Incurred by Government Contractors

THE charge has been made from time to time in recent years that the letting of this or that Dominion or Provincial Government contract has been influenced by money subscriptions donated by the successful contractor to the "party fund." For the most part, we believe such charges have been laid by political opponents who, in general, endeavor to fix the blame on government officials so that the party to which these officials belong may become discredited; for this reason the legal and moral aspect of the whole matter has been lost sight of, and, reprehensible as the practice may be, it has escaped the censure it deserves as a result of being made a political issue solely. Indeed, we believe it will be news to many, including contractors, that there is any legal aspect to the matter at all; but during a recent investigation into some public matters in one of our large cities we are advised that a law was brought to light which has been on the statute books of Canada for many years, but which, apparently, there has never been any effort to enforce. This statute reads as follows:

> **"It is expressly provided by section 158, subsection 1, of the Criminal Code, that it is an indictable offence for anyone having any contract with any government to subscribe or agree to subscribe any money or other valuable consideration for the purpose of promoting the election of any candidate or of any number, class, or party of candidates to any legislature or to parliament, or to subscribe with the intent in any way of influencing or affecting the result of a provincial or Dominion election. The Court is given power to impose imprisonment for not less than one month and not more than one year, and to impose a fine to the extent of the amount subscribed."**

The Act also provides that any prosecution for such offence must be commenced within two years, and, further, that any person convicted under this Act shall thereby be rendered incapable of contracting with the government or of receiving any benefit under any contract which he has with the government, or of holding any office under the government.

To what extent this law has been transgressed it is, of course, impossible to guess, but there is little doubt that ignorance of its existence has been responsible for much of the trouble. We bring the matter to the attention of our readers, therefore, chiefly because we believe it is a question upon which they would willingly become better informed. Many a contractor may feel that he is justified in taking advantage of a little political influence to gain him a contract which he believes he can carry out as well as, or better than, his competitor, but few will take a chance on a year's imprisonment, however great the monetary gain. A more general realization of the existence of this law should work out advantageously to the government, the contractors, and also to the public at large, who pay the bills.

Engineering Education

EDUCATION in engineering should be primarily a systematic cultivation of the natural abilities of the individual student, and should be concerned only secondarily with acquiring knowledge of facts or of methods of using them. This, in a sentence, expresses the fundamental idea upon which Professor Higbie based an address before the recent meeting of the American Association for the Advancement of Science. Professor Higbie's paper was intended to indicate just what college training for engineers may reasonably be expected to accomplish, and the views expressed therein are substantially in accord with those of a considerable number of able practising engineers of wide and varied experience who responded to a questionnaire, sent out by Professor Higbie two or three years ago, and which covered broadly, as well as in detail, the purpose, scope and content of courses and methods of instruction in various branches of engineering.

The basic idea is that education, so far as engineering is concerned should not be judged solely by the amount or kind of knowledge dispensed, nor by the particular facts and laws which are learned. The prevailing opinion of engineers of note in their profession is, rather, that college training exhibits its most potent influence by a development of a character or frame of mind. Critics of engineering education, says

Professor Higbie, may, in general, be designated idealists and materialists. The former are inclined to regard as of utmost importance the habits and character training which college life produces, while the latter are more interested in the ingraining of specific information; in other words, they measure educational value by mere facts, not by the habits which will result in a better application of these facts.

The matter of education is, at best, open to debate. Opinions regarding the scope, nature and contents of educational courses are as divergent as night and day. Engineering education, in particular, offers an even more complex situation, for engineering is peculiar in being not a mere scholastic accomplishment, but rather a combination of the theoretical and practical; in other words, real life must modify and amplify pedantic attainments. The engineer must not be merely erudite, he must be useful, and to be useful he must have felt the effects of the knocks and jolts of a contact with men. The school of life itself must, in this case, be a co-partner with the school of thought. Having this view, then, it is apparently essential that a college training should be merely a stepping-stone to the wider and broader graduate training. Many men have reached fame and station as engineers who could not boast of a university education. Their fame has not been lessened a whit thereby. Yet engineers whose experiences have been gained in part inside the walls of a college have testified that the real satisfaction of such education has come, not from the mass of facts and data that has been disbursed, but from the habits of persistence, accuracy, thoroughness, observation and independence of thought which have been ingrained, habits which have made an easier path to hoe, and which have made the experiences of real life less trying.

The exact procedure in realizing, or attempting to realize, this ideal of educational usefulness, is for the teaching mind to formulate. The teacher holds to a large extent the key that opens the way to a broadening of college instruction. If he is a man of well-rounded personality, of high character, and of commanding force, he can exert an effective personal influence on the student which may do much to lay a good foundation for engineering work and train the stamp of men the world wants—thinkers and doers. The subjects which a college aims to teach must be clothed with a certain vesture that gives life and interest. This is true of such subjects as mathematics,

One paragraph of Professor Higbie's paper in particular touches upon what, we believe, is the real failure in engineering education. "The training of the engineer," he states, "ignores or places too little stress upon the business of life, upon political and broad social interests and problems, with the result that the engineer does not take that commanding place in the management of human affairs to which his training, his knowledge and his character entitle him, and that he does not receive his due share of the material benefits of his labors."

This expresses an opinion that our editorials have repeatedly advocated. The engineer, through his connection with world-development, and by virtue of his constructive mind, is admirably fitted to occupy the pedestals of a more influential public life. At the present moment the sun is beginning to break through the clouds and the engineer is coming into his own. His scope of activity is not any more the limited sphere of subserviency; he now operates in the domains of world influence and power. To fit himself for his new place, the engineer's training must be as broad as it is comprehensive, it must lay stress on the requisites which this new adaptation involves. It is in this that engineering education requires revision, remodelling and reclothing. It must enable the engineer to take "his place in the sun."

Manitoba Branch, C. S. C. E., Approves of Research Laboratories

The Manitoba branch, Canadian Society of Civil Engineers, held a regular meeting on the evening of January 4. It was decided to approve the principle contained in the bill proposed by the Electrical Section, providing for legislation regarding licensing electrical contractors and journeymen.

Prof. E. Brydone-Jack addressed the meeting on the relation of the society to scientific and industrial research. The speaker referred to the absolute need for organized effort in research and investigation, emphasized and brought before the public on account of the war. He then gave the history and details of organization of the British Committee on Scientific and Industrial Research, followed by that of the Canadian committee, which is being formed along lines similar to the British committee, and finally the committee appointed by the university faculty, all indicating the development of public sentiment along this line. The British committee consists of (1) a committee of the Privy Council; (2) an advisory council of experts; (3) standing committees on engineering, metallurgy, and mining. The Canadian committee has not yet appointed any standing committees, and Prof. Brydone-Jack directed his remarks to the standing committee on engineering.

The paper was followed by a lively discussion on the subject, after which the meeting again went into business session and adopted the following resolutions:

That the Manitoba branch, Canadian Society of Civil Engineers, is heartily in accord with the idea of establishing research laboratories at the various industrial centres throughout Canada, and would urge for favorable consideration by those in charge the establishment in Winnipeg, Manitoba, of an experimental station for physical and chemical research relating to Western industrial and civic problems.

That this branch urge upon the society, in annual meeting assembled, consideration of the question of recommending to the Canadian Scientific and Industrial Research Committee the appointment of a standing committee on engineering and the nomination of certain members on such standing committee not exclusive of Western representation.

That the chairman appoint a committee to make a special local study towards forwarding the purposes of the Canadian Scientific and Industrial Research Committee.

"The people of Canada should practice economy, which results in greater national saving. Every man over twenty-one understands how to economize, and every man can carry it out if he wants to carry it out. Let us economize. Let us make our savings serve the purposes of war. Let the people of the Dominion, by thrift and economy, make their dollars fight the Hun."—Sir Thos. White.

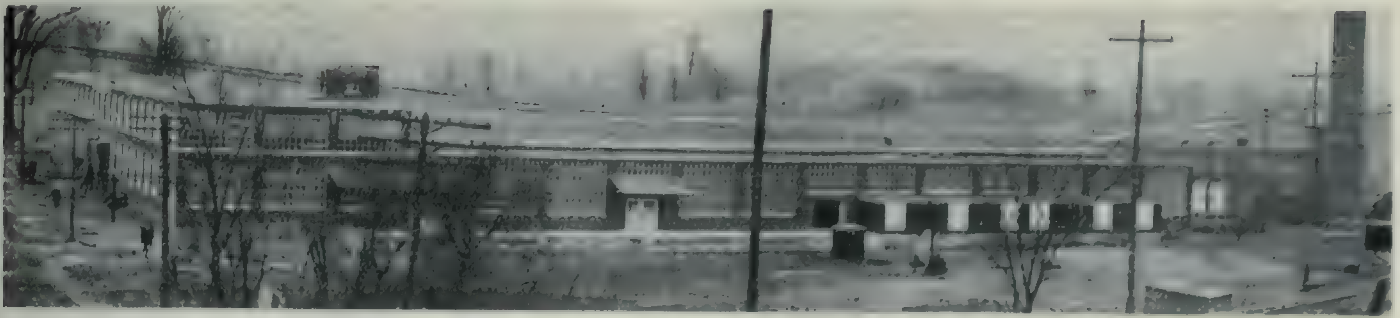

Fig. 1.—Factory of Canada Cycle and Motor Co., at Weston, Ont., nearing completion. Reinforced concrete office portion on the left; power house, stack, and water reservoir on the right.

Interesting Erection Methods Employed on New Steel and Concrete Factory

A NEW factory is just being completed for the Canada Cycle and Motor Company, Ltd., at Weston, Ontario, on the Dufferin Road. Fig. 3 shows the general outlay and plan, while the illustrations, Figs. 1 and 2, show the building in two different stages of erection and serve to indicate the type of construction being employed. One of the photographs gives an idea of the appearance of the completed factory. It is being built for manufacturing purposes, and has been designed to secure economy by keeping operations on the ground floor and at the same time to obtain the greatest amount of light. One side of the building is intended largely for office use, this portion being two storeys high.

The main part of the plant is one storey in height, and is rectangular in plan, measuring 280 feet by 208 feet. This portion is for factory purposes, and ample provision has been made for light through the roof and walls. The office quarters are accommodated in the front of the building, in a portion measuring 50 feet by 280 feet in plan. The size of the whole factory is thus 258 feet by 280 feet. A brick power house, separate from the main plant, supplies heat and power. Fire protection is obtained through connections with the town water system. A reserve reservoir, of reinforced concrete construction, located outside the building, forms a secondary protective device. The location of the plant is close to railway facilities, a siding being installed alongside the building.

The front part of the building, which is two storeys high, is of reinforced concrete and brick construction. The foundation piers are of concrete, and the first storey has reinforced concrete columns, 14 inches square, spaced at 16 feet centres. The walls are brick. The upper floor has concrete girders, 14 inches by 30 inches, with a combination hollow terra cotta and concrete joist floor, measuring 10 inches in depth. The second storey walls are of solid brick, with interior columns of steel. No concrete construction is used on this storey. The roof is flat and of wood sheeting on steel wall-bearing girders, covered with Johns-Manville prepared roofing. The floors are finished with cement or linoleum. The concrete was a 1:2:4 mix, machine-mixed and poured from buggies. A steam-operated hoist was employed to elevate materials to the upper floor.

The major portion of the building forming the factory proper is one storey in height, and is entirely of steel construction. There is no basement, and the foundations are small square concrete pedestals, with spread footings, carried down to a minimum depth of 3 feet 6 inches, or below the frost line. Each pier takes a column, the cross-sectional area of the pier being varied to suit the loading requirements. The outside columns are supported on continuous foundation walls of concrete, with spread footings, on which the outside brick walls are built up. The columns are of 8 inch Bethlehem, H section, with a clear height of 12 feet below the roof trusses. They are spaced at 16-foot centres in one direction and 40 in the other, with steel roof trusses spanning the long bays.

Roof lighting is provided by a special monitor construction giving east and west light. In Fig. 3 the shape of these monitor trusses is shown. Drainage from the valley is taken care of by frequent interior downpipes. These monitors are provided in every second bay only, the other bays having simple skylights. Monitor sash, swinging outward, are fitted to the monitor structures.

The outside walls are of brick, carried on the concrete foundations, and are 9 inches thick between columns and 13 inches thick at the columns. Steel win-

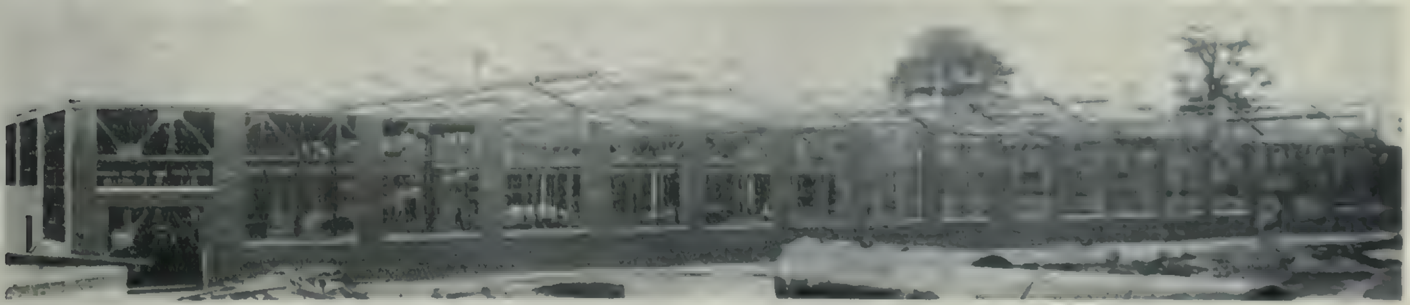

Fig. 2.—Factory during erection, showing steel construction with brick facing. Note special monitor roof design.

dow frames, extending from the sills to the eaves, are used. The roofs are of 2¾ inches tongue and groove sheeting on 6-inch by 10-inch rafters, carried on the steel trusses, covered with a prepared roofing. Drainage is through interior downpipes and outside eaves. The floor of the factory is of 4-inch concrete on a 2-inch cinder base, with a 1-inch cement finish coat.

The large ground area of the building made steel erection more or less intricate, and for this reason special methods were devised to facilitate operations and allow the steel to be erected with the least interference and at the same time with speed. Materials were shipped to a railway siding, located about 200 feet from the building, where a wooden unloading derrick transferred the steel to a motor truck, which carried it to the site. For erection a special traveller was rigged up, consisting of a wooden stiff-leg derrick mounted on a frame fitted with wheels and running on rails having a 30-foot spread. This frame was made of H section beams. The derrick had a wooden boom 77 feet long and was equipped with a steam hoisting engine providing power. The rails were laid on three sides of a square within the area of the building, as shown in Fig. 3, the entire series of roof trusses being placed by the traveller operating along these tracks. The traveller was started at one side of the building, and it erected all of the trusses in front of it. When it reached close to the other side, the frame was jacked up and the wheels turned at right angles, the traveller then running down that side, erecting trusses as it went. The remaining steel was erected by operating the derrick along the third side of the square. The trusses were shipped to the job already fabricated in 40-foot lengths, and were erected in this way. The length of the boom enabled the traveller to cover a wide sweep. The methods were devised for speedy erection, since the intention was to build the factory against time. The labor conditions, particularly a shortage of men, hindered operating and retarded the work very considerably, however. One erector gang did all of the work in connection with the erection, and helped in unloading as well. To show how speed was provided for, the wheels of the traveller were not fastened by fixed collars, but were free to slide traversely on their axles so as to accommodate any irregularities in the setting of the rails. This means that the rails do not need to be laid with a great deal of accuracy.

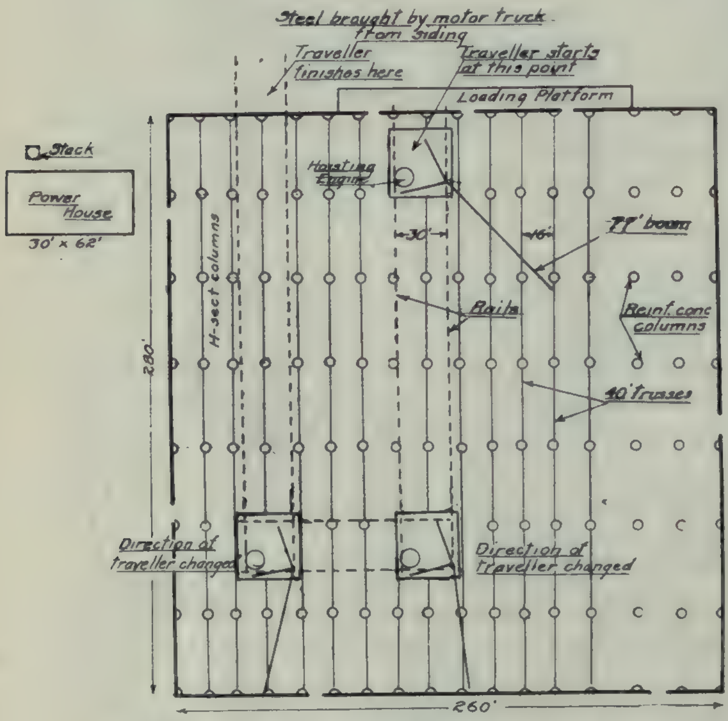

Fig. 3.—General layout of building showing the scheme adopted for erecting the steel

A separate power house is located at one end of the factory. It measures 30 feet 2 inches by 62 feet, and is built with brick walls, the roof being carried on wall-bearing steel sections. The equipment consists of two return-tubular boilers of 300 h.p., with provision for doubling the capacity in the future. They are equipped with Jones underfeed stokers. A steam-driven air compressor and a fire pump are also provided in the power house. The air compressor supplies air under pressure for shop processes, while the fire pump is used for supplying water in case of breakdown in the town mains during fire. The stack is of the Custodis radial brick type, and measures 125 feet high by 5 feet 6 inches inside diameter at the top. It is built on a concrete foundation. Heating is by direct radiation in the office portion only, the exhaust steam being employed in the radiators. Indirect heating is used in the factory, with ventilation ducts and three steam-operated fans located in the shop. There are a number of dry kilns and enameling ovens in the factory heated by steam. Power for the machines is supplied by electric motors.

A sprinkler system is provided to take care of fire protection. This is connected to the town water supply, the pipes being always under pressure. The overhead gravity tank is dispensed with. In case of breakdown in the town mains or pumping equipment, a fire pump is installed in the power house connecting to a reservoir or cistern outside of the building. This tank is built of reinforced concrete, and is circular in shape. The diameter is 52 feet, while its capacity is 100,000 gallons.

The plant is equipped with a complement of appliances such as plating tanks and sand blasts. A shaving exhaust is also provided.

Prack & Perrine, of Toronto, are the architects and engineers for the factory. The general contractors are the Deakin Construction Company.

Gas Defence and Attack at the Front Described to Montreal C.S.C.E.

Mr. W. B. Campbell, B.Sc., who spent a year in the trenches engaged on special chemical engineering work, addressed the members of the Canadian Society of Civil Engineers, Montreal, on Jan. 11, on "Gas Defence and Attack at the Front." He described the chemicals used by the Germans, the conditions suitable for attacks, and the various masks used for protection by allied soldiers. Samples of these masks and two German protection devices were exhibited, Mr. Campbell stating that the British masks were much more efficient than those used by the Germans. While the first ones were crude, the allies had evolved masks that were very effective.

A Correction

In an article published in the Contract Record of January 17, by Mr. W. W. Pearse, C.E., city architect and superintendent of buildings, Toronto, the line immediately preceding equation (19) should read $Mt/2=$, $wL^2/57$ and equation (19) $Mt=wL^2/28.5$. In consequence, equation (20) should also read $Mt=WL/28.5$.

Modern Fireproof Construction

An Outline of the Methods and Designs Adopted in Erecting Buildings of this Kind—Typical Instances Occurring in Toronto

By W. W. Pearse, C. E.*

THERE are two distinct types of modern fireproof construction, known as "steel skeleton construction" and "reinforced concrete."

The "steel skeleton construction" has, without doubt, held first place up till to-day, due to the fact that the steel work can be run up to almost any height in an incredibly short time; the balance of the construction follows immediately. Sometimes—in fact, generally, the brick and stone work are started at different storeys, the upper part frequently being finished before the lower storeys are commenced. This is usually caused by the lower storeys being built of stone, a material more difficult to get.

Buildings up to twelve storeys in height are generally built in what is known as curtain wall construction, which means that the walls are self-sustaining. This usually applies only to the side walls, the front being almost invariably built of skeleton construction, which means that at each floor the brickwork is supported.

Buildings of twelve storeys in height are usually erected inside of one year. It will take about one month to excavate, another month to set the concrete footings and the grillage; the balance of the steel work will then be erected at the rate of approximately one tier per day, making about two weeks time when the steel work is up to the thirteenth tier. The rivetters are usually about one week behind the erectors; the brickwork and floor arches are usually about two tiers behind the iron men. It will then be seen that this leaves considerable time to put the finishing touches on the building to complete inside of the year.

Steel work has been able to overcome all the difficulties of construction caused by wind stresses and tremendous dead loads, and, in my opinion, will never be superseded by any mode of construction for buildings more than twelve storeys in height. This is particularly true when you consider that practically all the material used in these modern buildings is fabricated at the shop, all marked for erection; the foreman of the different trades is furnished with drawings which show where every piece is to go. This is true for practically all trades, such as stone work, terra cotta front work, steel work, plumbing, heating, etc. By this method these huge buildings are rapidly and economically constructed. Another good quality is that they are very readily inspected, both in the shop and in the field, and each individual unit carefully calculated and constructed to meet the stresses coming thereon.

Referring to the reinforced concrete buildings, this type of construction has undoubtedly come to stay, and I might refer you to some of the modern buildings that are being erected in Toronto, one being the Trusts and Guarantee Building, on Bay Street, which is eleven storeys in height, having girders for one storey built of concrete of the full depth of the storey and carrying interior columns which have considerable loads coming thereon. This type of construction is what is known as beam and girder reinforced concrete—in other words, reinforced concrete beams and girders take the place of steel beams and girders in the steel skeleton construction.

Another type is what is known as the four-way flat slab construction. An example of this construction is well illustrated in the new mail order building of the Robert Simpson Company, and I might add right here that the City Architect's Department, in conjunction with the University of Toronto, have conducted some very satisfactory tests on this type of construction, and which I hope to have published later.

Another type of concrete construction is the new Eaton factory building which is being erected on Downey's Lane and Alice Street. This building is a twelve-storey one, and is a combination of flat-slab construction and skeleton steel. The columns are built of steel work of such shape that the concrete when poured around them reinforces them, and we have a steel column reinforced with concrete, whereas in the Simpson building we have a concrete column reinforced with steel. The Eaton building, then, has floors constructed on lines similar to the four-way type of construction.

I will not go into this type of construction very thoroughly, but would refer you to the "Contract Record and Engineering Review" of January 17, 1917, where I have endeavored to analyze fully this type of construction, and have also given what I hope will be a useful table for carrying loads, etc.

In considering the use of concrete and steel I have found that usually the engineer is biased one way or the other. Sometimes the engineer is trying to sell steel, and naturally he uses steel when concrete would be more economical, and the same holds true with the concrete engineer; he oftentimes will build prodigious girders, etc., of concrete when steel would be much lighter and stronger.

The different floor systems are almost infinite, but they usually resolve themselves down to terra cotta, brick, gypsum, cinder or stone concrete. The terra cotta is usually built of either flat or segmental arches, and so designed as to cover the bottom flanges of the steel beams. Brick is almost invariably built in rowlock arches, and is never used except where very heavy loads are to be used; then these are very carefully tied together with steel tie-rods. Tie-rods are also used in the terra cotta arches to take up the outward thrust on the wall panels. Gypsum is usually used with some type of reinforced wire meshing or expanded metal, and is then poured, four inches thick, on top of previously arranged wooden forms. Cinder and stone concrete are also used that way. The forms are so arranged that the concrete will cover the bottom flanges with about two inches of material.

Mr. Pearse concluded his article by illustrating, with lantern slides, various types of building construction. One of these showed a typical engineer's floor plan of an ordinary loft building, 50 feet wide by 90 feet long and sixteen storeys high. The beams were arranged to form three panels. This method was adopted in order to reduce the bending moment on the girder, for if a central load had been applied it would have increased the bending of the girder considerably. The columns were arranged so as to reduce the span of the girders, and the wall columns, so as to give the greatest resistance to bending due to the eccentricity of the dead and live loads; also to resist the bending caused by the wind loads. This type of construction is self-sustaining. In other words, the walls between the columns are supported at the foundation. One section showed skeleton construction—that is, a wall that is carried at every floor. This is a much more expensive type of construction than the curtain wall type, due to the fact that there has to be steel added to carry the walls; then all the brick load has to be taken by the columns. This type of construction for a building of the size shown would make a difference in cost of between three and four thousand dollars in the steel work, and would add an additional cost to the brick work of about seven hundred dollars; so it is readily seen that for a building, say up to sixteen storeys in height, curtain walls are much cheaper than the skeleton type of construction. The present Toronto by-law does not allow curtain wall construction, though its use is allowed, due to the fact that 90 per cent. of all the buildings in New York City up to twelve storeys in height are of curtain wall construction, which Mr. Pearce considers a sufficient precedent.

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*City Architect and Superintendent of Buildings, Toronto, before the Insurance Institute of Toronto, Jan. 18, 1917.

Another slide showed a floor system used in fully 75 per cent. of the loft buildings in New York City, composed as follows: A wire mesh is usually put across the top of the "I" beams (preferably continuous); the forms are placed underneath, and four inches of cinder concrete of 1:3:5 mix is then poured for a floor slab. On top of this are placed wood sleepers, spaced about two feet centres, and filled in with what is called a dry mixture of cinder concrete. To these sleepers is then nailed the wood flooring. This gives what is called a top system, the ceiling having a beamed effect. This, of course, lightens the load on the beams and columns, and is much cheaper than either terra cotta or stone concrete. The question of fire resistance is quite a debatable point. Mr. Pearse stated that he had written to Chicago, Philadelphia, and New York, requesting them to state if they had ever found any buildings of this type of construction showing deterioration which the ordinary terra cotta or stone concrete did not show, and in all cases the reports have been favorable, providing pipes through which water or other liquids are to pass were covered with a sufficient quantity of cement to prevent any moisture from setting up a chemical reaction with the sulphur in the cinders.

Other slides showed a skeleton diagram of the approximate method of figuring the reactions on columns due to the wind; the usual method of getting up a column schedule giving the loads; a method of cantilever construction; the usual type of foundation which is carried down to rock and is composed of piers of concrete anywhere from ten feet to fifty feet in depth; a cast iron base which is often employed; a rough sketch of the ordinary type of gusset plate base which is quite popular with the structural steel engineers; a built-up steel base, constructed of channels and plates rivetted together, having bolts and separators and steel diaphrams placed under the centre of the columns; an analysis of the wind stresses taken at the fourth floor; the bending moment diagram of the steel columns caused by the wind; the bending moment of the girders; a popular bracket to resist the bending moment of the wind; a heavy wind bracket, very popular with the American Bridge Company and other construction companies doing heavy work; the usual column splice for a Bethlehem column or angle or plate column; the method adopted in calculating the stresses in a column when an eccentric load is applied; a modern fire tower and the type of old staircases; and a few formulae for reinforced concrete.

Mr. Pearse was followed by his assistant, Mr. Mylrea, who showed some very interesting slides of the Quaker Oats plant, Peterboro, taken immediately after the fire.

What Policy for 1917?

By R. O. Wynne-Roberts*

THE year 1916, with all its policies and resolutions, has gone. What will 1917 have in store for us? Much will depend upon ourselves, and collectively we can shape the future. Unfortunately, as events have shown, there is no worldwide policy; hence this terrific warfare. It is, however, possible for Canadian civic authorities to unite in one policy, namely, research and reservation.

By research is meant the careful inquiry into all matters pertaining to city affairs, so that the maximum results may be obtained at the minimum cost. By reservation is meant reserving as much work as possible for the time when it will be most needed. These might constitute national policies, for the conditions apply to the Dominion generally as well as to municipalities.

In the "hustle-bustle" of former years it was not possible to make the inquiries which are so essential for the best work, because there was so much to do, and to make the full preliminary investigations would result in delayed execution of the work, which the public pressed for strongly. It is not implied that the works were badly carried out, for there is no reason for such an implication, but it will be acknowledged by those who have watched and thought that in some instances, at least, the work might have been designed differently had time permitted. City and other engineers are just as human as the rest of mankind and cannot work out miracles. They can turn out work as excellent as other men if given the opportunities of doing so. There is too much of the tendency to discuss schemes without the same having been carefully prepared beforehand and when decision is made to adopt them, the execution is expected to take place at once. Every municipality must eventually move either forward or backward, but there is always a short interval when the current is neither way. The year 1917 promises to be a kind of slack tide for municipal enterprises. It is during such a period that great preparation can be made for future progress, as the people can then concentrate as much thought as is practicable under war conditions, to study what is necessary and how best to undertake works which are essential for future welfare.

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Problems to Solve

Every municipality has a problem to solve or a number of them—it may be a good, pure water supply, a satisfactory sewage disposal scheme, good roads, refuse disposal, light and power, railways or other necessary public utilities. It may be the investigation of the efficiency of existing work, or the re-organization of present administration, or the preparation for town or city expansion in some form or other. There is no time like the present to consider these problems. The British Government, through the Local Government Board, recognizes this fact and **has called upon every civic authority in Britain to send in a statement of work now under contemplation.** This necessarily means that plans have been formulated, digested, discussed and approved. Have Canadian municipal authorities been mobilized for such work? Have the governments called upon the cities and towns to consider their ways and plans? Have the representative municipal organizations advocated a program of this kind? It is true we have heard individual leaders express opinions, but officially and through the organized departments and associations, no concerted action has yet been taken to advise careful enquiry into prospective schemes. It is perfectly easy to spend public funds in projects which are not maturely developed, but it requires time to consider and prepare schemes so as to obtain the utmost efficiency, both structurally and financially. European cities are organized for the future. They have their eyes on the tremendous task before them. They are aware of the difficulties of preparing at the last hour. And they recognize the importance of intense study and enquiry to secure the maximum benefits. Canada is in no superior position in this respect. With all deference to the municipal men—and we have many excellent workers on behalf of the public—we have to admit that in older countries where the councillors, aldermen and officials are intimately acquainted with civic matters by long service and loyal devotion, European cities are probably more highly organized than those in North America. On the other hand, the war has disturbed the ordinary administrations in Europe more than in Canada. Still, we have to face the fact that the problems to be solved in Europe are largely reconstruction, that is, rebuilding of cities according to plans which are now being prepared. Commissions have visited North America to study the methods, and the members are evidently intent on adopting the most modern ideas and invoking the aid of town planning advisors so as to construct towns on the most approved modern principles in place of the hundreds which have been smashed and obliterated.

Work for Canadian Cities to Do

What are Canadian municipalities doing meanwhile? Is there a general disposition of the available organizations towards a preparation for the day to come? Is there a "National Service Board" to direct and conserve the energies of the city councils in a Dominion-wide effort to make the best of our present opportunities? Ontario, through her Hydro-electric Power Commission, is organizing a great scheme of radial railways. The Dominion Government is preparing a great inter-provincial road scheme. There are, doubtless, other things in contemplation, and it is right and proper that just such programs should be instituted by the municipalities. Their scheme, of course, will be smaller and less spectacular, but nevertheless equally important. Public health must be conserved, industries must be fostered, conveniences must be furnished and generally the community must be made contented, although the last is not always easily done.

The water supply, to be abundant and pure, needs careful attention, and the cost must be reasonable. Efficiency in water supply involves a close study, for there are many disturbing factors. Waste should be kept at the lowest point; pumps should be maintained in good order; filters should be operated so as to secure the maximum purification. Ratepayers are often paying excessive rates for water supply because these conditions are not constantly and thoroughly maintained. There are many instances where the cost of pumping per head is abnormally high, and it is a puzzle to understand why the accounts are so willingly paid. It is also a source of surprise that fuel and energy is paid for when more than one-half of the water pumped simply runs to waste through leaks, fractures and decayed pipes. Ordinary business success depends upon the elimination of leaks of various kinds and the saving of discounts. There are cities in difficulties because the apparent demand is greater than the supply, and new works or pumps are proposed to improve the conditions, whereas it often needs but a careful inquiry and regular survey, with the application of legitimate powers, to obviate the extra capital expenditure. The first consideration in connection with public service is efficiency, that means maintaining the supply or work at top-notch condition. This, however, has often been looked upon with disfavor because the operating expenses are perhaps high, especially when based upon the quantity of water raised.

It is very easy to show a low cost per 1,000 gallons of water supplied, but when it is reckoned on the annual cost per capita the scale changes. For example, at Barrie, where the average consumption is about 30 gallons per head, the cost of water in 1914 was 14.70 cents per 1,000 gallons, or $1.61 per capita, whereas at Brockville, where the consumption was about 330 gallons per head daily, the cost of water was 3.17 cents per 1,000 gallons, or $3.80 per capita. These are by no means exceptional cases, as a study of the published statistics will prove.

Every Dollar Counts

There is no doubt whatever that the cities and towns could save enormous sums of money by careful inquiry and efficient operation. It must be remembered that the cities and towns also pay for the disposal of the water after it has been used, and it requires no argument to convince the thinking man that the less volume of water which is used, the less will be the cost of disposal of sewage. Will the policy of 1917 be in the direction of true economy? These are days when every dollar counts. If it had a certain value in former years, it certainly possesses an enormously increased potential and dynamic power to-day in the prosecution of the war to a triumphant issue.

Criticisms are of more value when they have the element of construction about them, and herein an effort is put forward to show how the municipalities can do much to promote their own interests at small cost. This may be thought ill-advised, coming from an engineer whose livelihood depends upon the promotion of new works. But the writer feels that to perform his duty to the municipalities, it must be done conscientiously, even if it may meet with scanty consideration. We all can encourage the expenditure of money, but we also are called upon to direct attention to the ways by which money can be saved, and that is most important. Municipal administration, to be successful, must be efficient in every way, for that is the very essence of true civic development. The writer has spent a lifetime associated with municipal work, and whilst it may be egotism to state that different authorities for whom he has worked have publicly passed resolutions of thanks for the services rendered and economies effected by him, it is alluded to solely to indicate that efficiency has been and will always be the object aimed at. This article is therefore based upon the experience gained and the knowledge that the results which accrued to the public by efficient administration can be translated into tangible dollars.

Reservation of Work

Whilst it is highly important that a very careful enquiry should be made before embarking on a project, it is at present of vital importance to the country generally that the municipalities, in common with the other governing bodies, should formulate schemes which are to be held in reserve for the returning heroes. What terrible confusion will ensue in this and other countries if due preparations are not now made, can only be contemplated with apprehension. The value of solicitation on behalf of the warriors may be measured by the timeliness of the organization. "A friend in need is a friend indeed" is a tried saying and needs no qualification. The returning soldier after many months of danger, horrors, mud and discomfort, merits something more practical than conventional expressions of appreciation of his services. He has done his duty and will measure the Canadian public by the manner in which it has done its duty. Organization to provide employment for all classes of men cannot be arranged at the eleventh hour, or when it is almost too late, without making confusion worse confounded. The year 1917 may and we earnestly hope, will see the end of the gigantic war. The men will be returned as fast as transport can carry them. What then will the situation be when the men return to civil life, anxious to resume their occupation with a firm determination that not a moment is to be lost to make up for the time spent in their unprofitable but stern, patriotic business of war?

Preparation for Peace

The policy of 1917 is manifestly one of general preparation for peace, and if it unfortunately does not consummate this year, we shall at any rate be ready for it when it does come. It must not be forgotten that thousands are in the trenches, who in civil life were employed in technical pursuits, and on their return will expect to find something similar by which to be self-supporting. It may be engineering, contracting, manufacturing, industrial, etc., but as the present munition production will then have ceased, and unless there are other works to take the place of munitions, even the present workers will also be seeking employment. Will the soldiers have precedence over the civilians, or are these to clash and struggle in disordered society for what can be found? Even now, with all the talk about prosperity induced by munition orders, there are many who are unemployed. This can be seen by watching those who scan the bulletins at employment offices and the advertisements in the dailies, for their particular training and vocation are not in demand. If there ever was a period in the history of Canada—and the same applies to other countries—when comprehensive efforts should be made to organize all forces for the advent of peace, then 1917 is likely to be the most momentous. Canada, by virtue of the great things done in this war, has won the esteem of nations. Shall such estimation be forfeited by inadequate provision for a time which we devoutly hope will come soon? This needs no answer of words, but of deeds, and the leaders of municipal activities have the opportunity of shining with the brilliancy of the sun, after the dark and heavy clouds of storm have passed away. There are some of us who would rejoice in participating in the work of preparation, for there is nothing more truly necessary, apart from the prosecution of the war to the final and conclusive victory which shall re-establish order among nations and peace among all peoples.

Maintenance of Public Health

In conclusion, it is desirable to emphasize the importance of keeping the existing public health works in operation at the highest standard of efficiency, for whilst we are engaged in an enormous strife that calls for so much human energy, it is essential that the service to the public should not be relaxed. Economy in its true meaning should, of course, be paramount in our minds and actions, but to fail in the effort of maintaining public health in the best possible condition will be tantamount to failure to secure the fundamental requirements of economy. Economy, after all, should not be a spasmodic virtue; it is necessary at all times, and the more efficient it is, the more valuable and lasting are the results. Progress must be measured by economical development. A contractor may have abundant work, but if economy is neglected it will often be better if he had less work. The same applies to all forms of organizations.

Completion of Mount Royal Tunnel

It is announced that the Mount Royal tunnel of the C.N.R., Montreal, is completed, with the exception of the laying of a double track. In addition to the construction of a temporary station, details of which have appeared in the Contract Record, arrangements are being made for the removal of 240,000 cubic yards of excavation for the site of the company's permanent station, plans for which have been prepared by Warren & Wetmore, New York. The larger portion of the rock will be conveyed through the tunnel to the Cartierville yards by two of the six electrical locomotives ordered.

Activated-Sludge in Chicago

Engineers of the stockyards interests and the Sanitary District of Chicago, after making a joint study of the proper disposal system, agree that the activated-sludge method will handle the sewage in a manner which will produce an effluent suitable to discharge into the main channel of the district. They also conclude that a community plant to take care of all the wastes from all the packing industries is better than the disposal by each company of its own wastes.

In the town of Hope, Ark., U.S.A., the waterworks department has arranged a well which gives the residents a choice of water from three different levels. Three faucets are provided, one giving fresh water from a 500-foot level, another water from a 1,480-foot depth, while the third supplies mineral water from a depth of 2,682 feet.

Causes of Cracks in Concrete Pavements

A Detailed Analysis of the Various Factors that Produce Failure in Cement Concrete Surfaces so Far as Present Knowledge Permits

By A. T. Goldbeck[*]

It is the intent of this paper to treat merely of the causes of cracking of concrete pavements in the light of our present knowledge of the subject. There are many phases of the question of cracking that might properly be brought out in a discussion of the paper, such as the effect of cracking on the life of the road, the expense of and best methods of the maintenance of cracks, and many other allied questions. All of these, however, have been avoided and an effort has been made to treat only that phase of the subject suggested in the title.

When the internal stress in a material reaches the ultimate strength, failure ensues, and manifests itself in various ways. In a brittle material like concrete, a crack indicates that the ultimate internal resisting stress, whether it is tension, compression, or shear, has been exceeded and, therefore, in order to analyze the cause of cracks in a concrete pavement, we must first discover the cause of the high internal stresses existing at rupture. This is a difficult task, as the internal stresses in concrete and reinforced concrete pavements are very complex and may be caused by a number of different phenomena acting simultaneously.

A concrete road slab is attacked by many forces which slide it, in part or as a whole, along its sub-base; which bend it and warp it; which subject it to impact and shear, and may even act within its interior to exert a disrupting effect. It is little wonder that concrete roads crack, since, due to the lack of experimental data, they are constructed without sufficient knowledge of the forces to which they will be subjected.

Complexity of Stresses

Let the life of a slab in the road be traced from the day it is poured in order that the complexity of stresses to which it is subjected may be studied. For about ten days or two weeks after the slab is laid and while the concrete is hardening, it is the practice, for several reasons, to keep the surface thoroughly wet. In the first place, water is necessary to hydrate the more inactive particles of cement, and, moreover, it has been discovered that as long as concrete is kept wet, its length changes but very little, provided the temperature remains constant. Any slight change that does take place due to moisture is favorable to the integrity of the concrete, because moisture expands concrete, and tends to produce small compressive stresses, owing to the frictional resistance at the sub-base against this expansive movement. Should the temperature rise during this initial period, additional expansion will result with increased compressive stress in the concrete. Even this combined compressive stress, however, is seldom likely to be very large during the initial stages of hardening, and may be neglected, as the concrete is generally sufficiently strong in compression to withstand the small forces then being exerted. Should there occur a large decrease in temperature during this initial period, the concrete will contract, causing it to move with respect to its sub-base. The forces of friction thereby developed produce tension, and as green concrete is weak in tension, a decrease in temperature, when the pavement is only a few days old, may cause cracks.

Suppose the pavement survives this initial period without mishap and is thrown open to traffic. Immediately it begins to dry out, and due to this cause it starts to shrink. The friction forces at the base immediately resist this shrinkage and the result is tension in the concrete. If the tension is too great the concrete cracks where the tensile strength of the concrete has been exceeded. As the sasons of the year succeed one another, the slab is alternately wetted and dried, and in addition, subjected to a wide range of temperatures, being thus kept in constant motion over its sub-base. The forces of friction are therefore in constant action resisting this motion, and thus cause stresses, now tensile, now compressive, to exist in the concrete. Should the forces of friction be sufficiently great, the resistance of the concrete is overcome and it fails, either in tension or compression, with one of two results, the concrete is cracked, or else bulged up or crushed. Sometimes moisture and temperature aid one another, and sometimes they counteract one another, but their activities are never ended during the existence of the road. Naturally, as friction can best be developed along the length of the road, temperature changes and moisture are promotive of transverse cracks rather than longitudinal cracks.

Bending Stresses in the Slab

In addition to direct compressive and tensile stresses, road slabs are subjected to bending, due to the loads of traffic and more likely, to unequal settlement of the sub-base, caused by lack of homogeneity. Uniform reaction between the slab and the sub-base due to frost may also produce cracking, the slab then being supported in some spots and not in others, thereby creating large tensile stress in bending. Frost action is more likely to cause longitudinal cracks than transverse cracks. The expanding and shrinking of the sub-base, due to varying moisture content, is also promotive of bending stresses and consequent cracking in the concrete.

In a general way, the foregoing discussion treats of some of the causes of cracking of concrete pavements, and these causes can best be classified as follows:

(1) Expansion and Contraction.
    (a) Change in temperature.
    (b) Change in moisture content.
(2) Ununiform bearing under the slab.
    (a) Frost action.
    (b) Lack of homogeneity in sub-base.
    (c) Moisture expansion and shrinkage of the sub-base.
(3) Excessive bending stress due to heavy loads and impact.

These causes will be considered in detail so far as our present knowledge will permit.

Expansion and Contraction

Effects of change in temperature.—It has been well established by several investigators that concrete expands and contracts as the temperature changes, and the amount of movement equals 0.0000055 inches per inch of length per degree change in temperature. If a concrete road is built in the summer season when the temperature is 90 degs. F., and the temperature in the following winter falls to 0 degs. F., the concrete must contract an amount equal to 0.0000055 × 90 = 0.000495 inches per inch of length. This contraction could do no harm if it were not for the resistance offered by friction between the sub-base and the slab. When the concrete contracts, the friction at the base resists the contraction and the amount of tension produced in the concrete is dependent on the amount of friction acting. Friction at the base varies with the kind of base and the degree of roughness, and tests recently made by the author throw some light on the amount of friction that can act at the sub-base when the slab expands and contracts.

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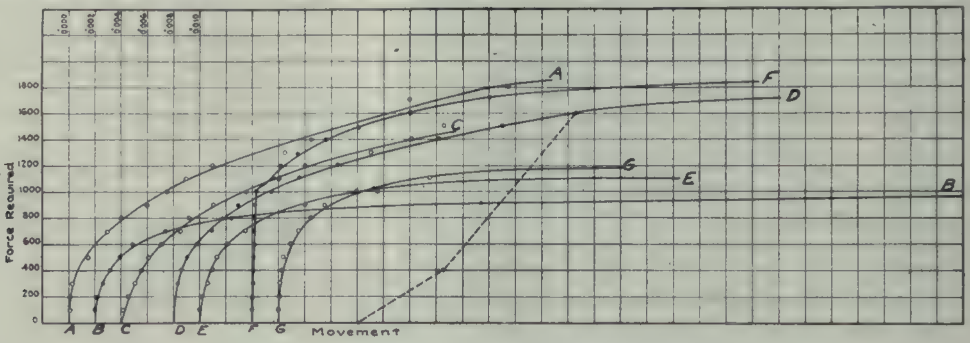


Fig. 1—Friction tests of concrete on various sub-bases; A, clay base; B, broken stone, ¾ in. to dust; C, loam; D, uneven clay base; E, ¾ in. gravel; F, large broken stone, 3 in.; G, sand base.

Friction at the Sub-base

The tests referred to above were made by sliding two-foot by six-foot by six-inch concrete slabs along previously prepared sub-bases. The sliding force was applied by means of a long lever and the magnitude of the force was measured with a carefully calibrated dynamometer. The amount of movement of the slab was read with a Berry strain gauge, while the load increased slowly and steadily.

The curves in Fig. 1 best show the results obtained. Note that as the load was applied, the slabs seemed to move very slightly, even at the first application, except where a sub-base of large broken stone was used. In this instance a high load was necessary to start the slab in motion, after which it required no more load than some of the other bases. Apparently there does not exist a constant value for the coefficient of friction, for the greater the displacement the greater the force of friction becomes.

The values of the frictional resistance offered at various displacements are given in the following table:

Table Showing Frictional Resistance Offered at Various Displacements.

Kind of Base	Movement	Force	Coefficient	Movement	Force	Coefficient	Movement	Force	Coefficient
Level Clay	0.001	480	0.55	0.01	1130	1.5	0.05	1800	2.07
Uneven Clay	0.001	500	0.57	0.01	1120	1.29	0.05	1800	2.07
Loam	0.001	300	0.34	0.01	1030	1.18	0.05	1800	2.07
Level Sand	0.001	600	0.69	0.01	1080	1.24	0.05	1200	1.38
¾-inch Gravel	0.001	450	0.52	0.01	960	1.10	0.05	1100	1.26
¾-inch Broken Stone	0.001	380	0.44	0.01	800	0.92	0.05	950	1.09
3-inch Broken Stone	0.001	1060	1.84	0.01	1550	1.78	0.05	1900	2.18

When the slab on the loam base had been slid 0.035 inches, the then existing load of 1,600 pounds was released to zero, and the slab recovered 0.017 inches of its motion. From this recovery behaviour it is seen that the sub-base acts in a somewhat elastic manner, and some of the resistance offered to the expansion and contraction of the slab must be that necessary to deform the sub-base. The material of the sub-base is far from being perfectly elastic, and it must therefore gradually yield under a slowly applied load such as would obtain in the expansion and contraction of concrete pavements. Hence it is not at all reasonable to assume that the maximum friction shown in the tests described actually exists in concrete pavements, even where their movement is large. The above tests were made in periods of about ten minutes each, while the corresponding movements in the road might take days.

Moisture Shrinkage

When a specimen of concrete is permitted to harden under continually moist conditions, it expands slightly; on the other hand, shrinkage takes place when it hardens in a dry atmosphere. The amounts of expansion and contraction are dependent to some extent on the richness of the mixture and also on the thoroughness of the drying. In Fig. 2 may be seen the effect of moisture on concrete. The specimens shown were 1:2:4 and 1:3:6 concrete of very wet and very dry consistency. Several days after hardening they were immersed in water and extensometer readings were made on them at frequent intervals. It will be seen that as long as they were wet they remained expanded, with the maximum expansion of 0.0001 inch per inch of length. After six months they were removed from the water and allowed to dry out in the warm dry air of the laboratory, when they immediately began to contract, reaching an ultimate contraction of 0.0008 inches per inch of length. It must be emphasized, however, that these specimens became exceedingly dry in a very short time after their removal to the air of the laboratory and probably very much dryer than they could ever become in the road.

When specimens are subjected to the everyday wet and dry conditions, they do not change in length very much, due to change in moisture content, because their moisture content does not vary greatly under such conditions. Concrete in the road may, under exceptional conditions, be made to suffer extreme drying, but it is very probable that most concrete roads absorb much water by capillarity from the damp or wet underlying sub-base, and moreover, the water that is absorbed during a period of wet weather does not completely evaporate between successive spells of wet weather. However, there is sufficient evaporation from the surface to cause some shrinkage of concrete in the road as evidenced by the formation of cracks when road slabs are allowed to dry out too quickly. The maximum amount of shrinkage that concrete can reach is 0.0008 inches per inch of length, but it is probable that, in general, the moisture shrinkage of concrete road slabs does not exceed more than 0.0004 inches.

Experiments have shown the effect of moisture on concrete that has already dried out and contracted, and has been reimmersed in water. Expansion takes place under the action of the water, small in amount at first, but finally, after a few weeks, amounting to three or four ten-thousandths of an inch. The moisture, however, does not seem to expand the concrete back to its original length, for it falls short of this by several ten-thousandths.

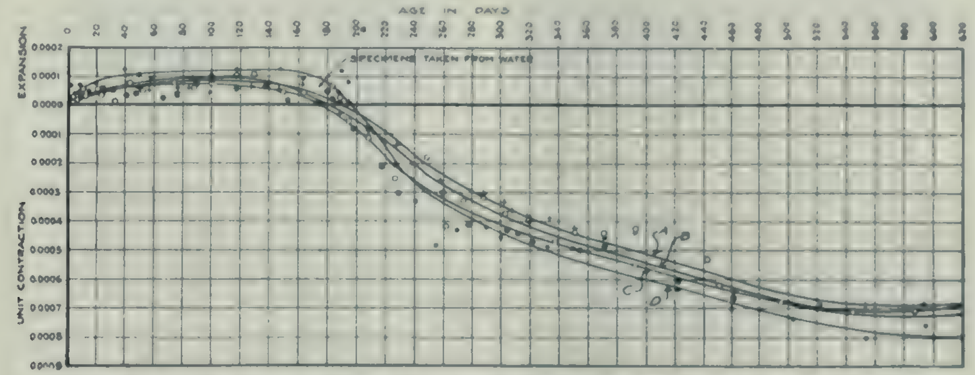


Fig. 2—Effects of moisture on concrete of the following mixes: 1:2:4 very wet; 1:2:4 very dry: 1:3:6 very dry.

Combined Moisture and Temperature Changes

It is evident, therefore, that both moisture and temperature act to cause creeping of the slab in the road, and it must be realized that the relative magnitude of these two effects depends on the range of temperature, on the rainfall, and on the drainage of the sub-base. In an exceptionally well-drained sub-base and in a dry climate, the moisture shrinkage of the concrete will be large, and will add to the contraction due to changes of temperature. This shrinkage may amount to 0.0004 inches per inch of length, and if there is a decrease in temperature of 100 degrees Fahrenheit there will be an additional shrinkage of 100 × 0.0000055 = 0.00055 inches, or a total shrinkage of 0.00095, or, roughly, 0.001 inch for each inch of length. On the other hand, there may be much moisture in the sub-base which will keep the concrete expanded 0.0001, and the net shrinkage will then equal 0.00055 minus 0.0001 or only 0.00045 inches.

It has been pointed out that the sliding of concrete along the sub-base develops frictional resistance of considerable magnitude, and when the tension developed in the concrete due to the forces of friction exceeds the tensile strength of the concrete a crack must form. Let the coefficient of friction be equal to 1.0, and assume the tensile strength of the concrete to be 150 pounds per square inch, and let L equal the distance between cracks, then, in a slab 12 inches wide and 6 inches thick, the stress at rupture equals 72 sq. in. × 150 pounds, equals 10,800 pounds. This stress must be supplied by the forces of friction acting over the distance between cracks, or $fLw = 72$ sq. in. × 150 pounds per square inch where w equals the weight of the concrete per linear foot and f equals the coefficient of friction. This equation reduces to $1.0 \times L \times 72 = 72 \times 150$ or $L = 150$ ft., the distance between cracks.

If $f = 2.0$, then $L = 75$ ft., so that the greater the friction the closer will be the spacing between cracks.

Smooth Sub-Base Essential

The above calculations indicate the advisability of forming the sub-base as smoothly as possible. Of course, the tensile strength of the concrete cannot obtain unless the concrete is stretched sufficiently. When 150 pounds per square inch exists in the concrete, each inch is stretched $150/3{,}000{,}000 = 0.00005$ inches, where 3,000,000 is the modulus of elasticity for concrete, and it has been shown that the shrinkage due to moisture and temperature change may amount to 0.00095 inch, far in excess of the amount required to cause rupture.

The foregoing considerations are based on mature concrete. When the concrete is only a few days old, the tensile strength is very small indeed, and the modulus of elasticity is likewise low. When but two days old the tensile strength may be as low as 50 pounds per square inch, and the modulus of elasticity in tension may be only 1,000,000. The stretch required to produce rupture is then $50/1{,}000{,}000 = 0.00005$. This amount of shrinkage could readily be caused by slight drying out or by a decrease in temperature of only $0.00005/0.0000055$ = approximately 9 degrees Fahrenheit. A comparatively small decrease in temperature may thus produce cracking in the concrete pavement. If the tensile strength at two days is only 50 pounds per square inch, the distance between cracks, when the concrete contracts sufficiently, will be smaller than it is if the concrete cracks at a later period when it has attained higher strength. Assuming the same values for friction and weight of concrete as before, we have $fLw = 50 \times 72$, or $1.0 \times L \times 72 = 50 \times 72$ whence $L = 50$ ft. If the coefficient of friction equals 2.0, $L = 25$. There may be times, due to a big fall in temperature, just after the concrete has hardened and the tensile strength is exceedingly low, when the cracks will be much closer together than the above figures show. There are often cases when the sub-base contains projections and depressions that greatly add to the frictional resistance offered to sliding, and such a sub-base aids in the production of cracks at close intervals.

Field Measurements

In order to gain some idea of the actual changes in length which takes place in the road slab in place many field measurements have been made by the Office of Public Roads and Rural Engineering, and the accompanying illustration, Fig. 3, shows some typical results. These measurements were made on the Ohio

Post Road over a 300-foot section. In general, it will be noted that the expansions and contractions, as shown by the solid vertical lines, closely follow the temperature changes. The dotted and dash-and-dot lines indicate cracks and expansion joints. The large expansion reading of 0.3325 indicates a wide separation of the joint at which this reading was made. These readings are almost exactly what they should be for the temperatures noted, and moisture does not seem to have had much influence. On another and unplotted stretch of road, however, at the bottom of two steep grades, with very poor drainage, the expanding effect of moisture is plainly evident. It is thus seen that both moisture and temperature cause cracking across the road. Sometimes the moisture effect is most severe, and at others the temperature effect is most felt, depending on the climatic conditions and the character of the drainage.

Uniform Bearing Under the Slab

Irrespective of what may cause lack of uniformity of bearing under the slab, let it be assumed that due to some cause this unequal support exists. As an exaggerated case let it be assumed that the slab is largely supported at its two sides, and acts therefore as a simple beam. Assume a 16-foot roadway 6 inches thick. The fibre stress in the section of greatest bending moment then equals $S = Mc/I$ where s is the fibre stress, M is the maximum bending moment, I is the moment of inertia, and c is the distance from the neutral axis to the outside fibre. The quantity I/c is the section modulus. In this case $s = wL/8 \times 6/bd^2 = 72 \times 16 \times 16 \times 12/8 \times 6/12 \times 36 = 384$ pounds per square inch, having assumed a beam one foot wide. This value is close to that of the modulus of rupture of the kind of concrete used in road construction. The dead weight of the pavement alone is thus almost sufficient to cause cracking if the slab is afforded improper support. The same condition would hold if the pavement were unsupported at the sides but fully supported at the centre. Add the weight and impact of traffic to increase the bending moment due to dead load and it will be readily seen that under the right conditions of improper sub-base support, a longitudinal crack is likely to form.

Before considering these conditions producing improper support, let the amount of deflection of the slab at rupture be figured. In a simple beam uniformly loaded, the deflection at the centre, $D = 5/384 \times WL^3/EI$. Assuming a 6-inch slab, 16 feet wide and supported at its sides, the deflection under its own weight by calculation equals 0.164 inches. The slow yielding or "flow" of concrete acts to increase this figure and might even treble it, thereby making the possible deflection as much as 0.5 inches when the crack forms.

Regarding the causes of unequal bearing, nothing very definite may be said. It is generally recognized that unequal compaction of the sub-base due to lack of homogeneity and to ununiform rolling may cause more settlement in some spots than in others, and many sub-bases built of old telford or macadam roads are very likely to lack uniformity. Again, the well-known expansive effect of freezing can very readily act with different intensity in different parts of the road, thereby causing more than enough rise to produce cracking. The shrinkage of soils when they dry out and their swelling when moistened is an occurrence of everyday observation, and it is quite possible that the shrinkage of the foundation away from the concrete is sufficient in places to cause great bending stress with the formation of cracks in the concrete. The raising of the sub-base in spots need not be more than 0.2 inches to cause cracking and the expansive effect of the frost and the swelling and shrinkage effect of moisture on the sub-base may be considerably more than this. The writer now has some experiments in progress to show the effect of freezing and moisture on the vertical movement of the road.

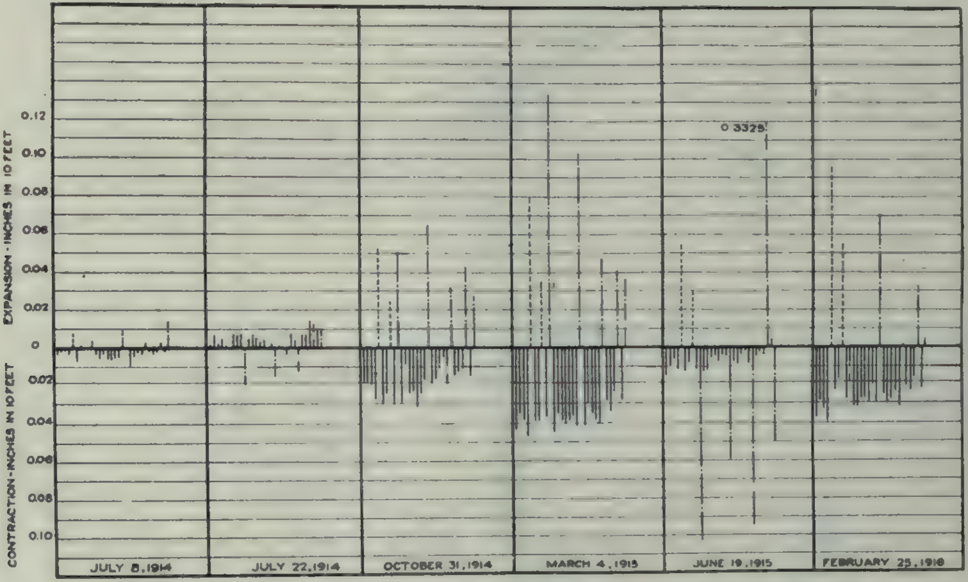


Fig. 3—Expansion and contraction of a typical concrete road. Temperature of pavement in degrees F: July 7, 82; July 8, 75; July 22, 85; Oct. 31, 50; March 4, 30; June 19, 68; Feb 25, 34.

Impact of Traffic

The weight of traffic serves but to accentuate the stresses due to the other physical causes. Heavy loads on a thin slab or where the bearing is ununiform may cause either transverse or longitudinal cracks, and when these loads are applied suddenly or with impact, as is the case with the modern heavy truck and steel-tired trailer, these loads will aid the other causes of cracking, although they may not be severe enough to be effective themselves. Traffic, however, often breaks off the corners of slabs, the load then being concentrated near a point having poor bearing.

In conclusion, it must be emphasized that great effort should be exerted to protect the concrete during its initial stages of hardening. Do not mix it any wetter than necessary to obtain smooth, yet economical construction. Protect it from sudden decrease in temperature and keep it wet for at least two weeks in order to prevent undue shrinkage while the concrete is green. Much attention should be given the sub-base, for, as has been pointed out, the friction at the base causes transverse cracks. This friction may be greatly reduced by proper care in the preparation of the sub-base and in this way the cracks may be widely distributed if not entirely eliminated. In addition, provide proper drainage to keep the sub-base as dry as possible, so that the effect of frost and the settlement due to moisture may be eliminated. Finally, design the slab as to thickness to carry the loads it is supposed to carry, irrespective of whether the sub-base offers uniform bearing or not.

Residence Involving Unusual Features

THE photographs reproduced herewith show construction views of the new residence being erected for Mr. R. S. McLaughlin at Oshawa, on the site of what was formerly Prospect Park. The extent of this structure, with the nature of its equipment, has demanded features of distinctive interest, and even in the methods of construction ideas were employed which are not usually associated with the building of so common a thing as a house.

Besides the main residence, there are the stables, garage, greenhouses, swimming pool, and bowling alley, to which the house is connected by a concrete tunnel. A separate gate lodge and barn are also being built, and the present concrete fence is being changed and cut stone entrances added to harmonize with the balance of the work.

The excavation was carried out chiefly with a steam shovel. The foundation walls are of concrete on concrete footings. By removing the forms from the walls before the concrete had dried and rubbing the exposed surface an excellent finish was obtained. During excavating a number of old wells were unearthed in the direct line of the basement walls. These were filled with earth, and, to ensure that no effects from settling would be felt, heavy reinforced concrete girders were placed across the wells to carry the loads, and wider footings were used.

The exterior walls are built up of Denison interlocking tile to a total thickness of 16 inches. The main partitions are also of Denison tile, while secondary partitions are studded. The exterior surfaces are covered with a stucco plaster, applied by hand. This is given a fine splashed finish. The plaster is applied to the tile directly, without the use of furring or a plaster bond.

The floors on the first and second storeys are of reinforced concrete slabs on concrete beams. The beams are 14 in. to 16 in. deep and spaced at 6 ft. to 15 ft. centres, depending on the loading. The slabs are 3½ in. to 7 in. in depth. The concrete is finished with hardwood, tile, or marble. Suspended ceilings are used to cover up the beams. For the attic storey a joist floor is used. The concrete was mechanically mixed and spouted into the forms, a tower and chute being used.

The roof is the usual rafter and plank type, covered with tile. All the sills and stone trim are of Bedford stone. On the front of the residence at the main entrance there are large circular columns, built entirely of brick.

The main stairway is rather unusual, so far, as

Exterior of residence at Oshawa, Ont., showing tile wall construction, also brick columns.

Exterior of residence with stucco finish applied to the tile walls.

least, as private work of this character is concerned. The stair is semi-circular, and built with marble steps, which are made self-supporting. The steps are built into the circular wall at one end to a depth of 6 inches and at the free ends each step rests upon the one below in such a way as to cause the whole stair to be supported by a sort of arch action without the use of the usual supporting walls.

The main heating plant is located under the garage, the heating pipes passing to the other buildings through a tunnel. Hot water is used for heating, the boilers being of the Kewanee horizontal tube type. The hot water is forced by an electric pump. A mechanical ventilation system with a separate fan provides an auxiliary heating service. A hard water supply is obtained through connection with the mains of the town of Oshawa. A soft water supply is collected in a cistern, purified by a charcoal and sand filter and forced by a pump to the house services. A complete ammonia refrigerating system, with an insulated cold storage room, is located in the basement of the residence.

All modern conveniences are also installed, such as vacuum cleaner system, electric push-button elevator, inter-room telephone system, and pipe organ.

Three concrete mixers were used on the job; also a concrete hoist tower, with spout conveyor system, and a building hoist and tower. A power saw rig was used for cutting the lumber for the forms, and a steel bar bender was employed for bending the reinforcing steel. Stone derricks and a steam shovel were also included in the equipment.

The work was started at the end of May, 1916, and the construction work is now completed. The interior finishing will be finished and the building ready for occupation about next July.

Messrs. Darling & Pearson prepared the plans, and Mr. John Dickie is superintending the work for the Dickie Construction Company, who have the general contract.

The tile was supplied by the Sun Brick Company and the cement by the Canada Cement Company. Purdy, Mansell Company provided heating and plumbing equipment. The elevators were made by Otis-Fensom Elevator Company, and the water tanks were supplied by the National Equipment Company, and the Tarvia by the Patterson Manufacturing Company. The cost of the home will be in the neighborhood of a quarter of a million dollars.

Letter to the Editor

Kansas City, Mo., Jan. 13, 1917.

Editor Contract Record:

After reading the interesting article about the disintegrated sewer in St. Vital, which appeared in the issue of the Contract Record of date Jan. 3, 1917, it occurs to me that the engineer who reports on the matter has not gone sufficiently into the method of curing or preventing such chemical action. He speaks of an impervious coating for the inside of the sewer. Is it possible he is referring to a vitrified clay lining of tile or pipe, such as was recommended by Rudolph Hering in a similar instance of disintegrated concrete sewer at Great Falls, and such as the Chicago Drainage Board used to protect their concrete sewers after I reported on the present condition of their Western Avenue sewer, which was even a more advanced case of chemical disintegration?

I recall that the A. S. T. M., after an exhaustive investigation of materials and methods for rendering concrete impervious, reported that none of the compounds now on the market could be relied on to produce the desired effect for any length of time.

Mr. Cantell's article is a very excellent one, as far as it goes, but I think he could add to it by continuing a discussion of the cure, as I have suggested. I am sure all engineers would be interested to read what he has to offer.

Yours truly,

The International Clay Products Bureau,
Benjamin Brooks, Engineer.

The Portland Cement Association states that 23,000,000 square yards of concrete roads, streets and alleys were placed under contract in 1916.

The American Wood Preservers' Association will hold its annual convention in New York, Jan. 23 to 25.

Montreal City Engineer Replies to Report of Ratepaying Engineers on Aqueduct Scheme

Mr. Paul E. Mercier, city engineer of Montreal, has made a detailed reply to the Ratepaying Engineers' report on the development of electrical power as a part of the Montreal aqueduct scheme. The previous report, which was published in the Contract Record of Nov. 29, 1916, consisted of twenty-two "conclusions." Mr. Mercier's report answers each of these conclusions in order, and concludes with a strong recommendation that the city proceed to complete the development work at once.

As a mere defence of the scheme for which, as city engineer, Mr. Mercier now feels called upon to stand sponsor, the report is manifestly a masterly effort. It is not so evident, however, that the arguments can carry conviction to the mind of the engineer who knows how ridiculous even the greatly reduced figure of $737 per h.p. is for a hydro-electric development. When it is considered that unlimited electric power is already available in Montreal which has cost, in capital charges, very little over $100 per h.p., it is quite impossible to conceive that a city-owned development costing seven times as much (even accepting this figure of $737 as against the $1,515 quoted by the Ratepaying Engineers) could ever hope to operate in such a way as to benefit the citizens at large. Mr. Mercier's detailed replies to the twenty-two conclusions of the ratepaying engineers are as follows:

Re Montreal Aqueduct—Answers to Report by Ratepaying Engineers, 1916
Conclusions

1. The capacity of the original aqueduct was sufficient for three times the present population served, if used for water supply only, and not for hydraulic power.

A. Was never discussed. The city was advised to construct the lateral conduit because: "It is an excellent plan for improving the quality of the city's water supply."—(Marceau & Kennedy, May 6th, 1907).

2. The cost of the construction of a filtration plant was the only further capital expenditure necessary to make the water from the original aqueduct ideal both for domestic and industrial use.

A. In their report of July 2nd, 1910, Messrs. Hering & Fuller said: "In speaking of the quality of the St. Lawrence water in this manner we refer to water drawn some distance from shore so as to exclude the influence of local shore pollution. We approve the proposition to extend the intake some 1,200 feet or more from shore and connect the same to the head of the present closed conduit. This will give a much better quality of water than is now drawn from shore, both as regards appearance and hygienic quality, and also give a water which is easy to filter."

This quotation corroborates the remarks made by Messrs. Marceau & Kennedy, referred to in Answer "1."

3. With the exception of the filtration plant and the pumping equipment, all expenditures in connection with the present project are chargeable to power development.

A. The changes recommended, i.e., the construction of a conduit, was: "An excellent plan for improving the quality of the city's water supply."—(Marceau & Kennedy, May 6th, 1907).

The same experts who stated in 1907 that the construction of the conduit would improve the quality of the water, state in 1916 that "No changes in the original aqueduct were required for an improved quality."

The conclusions made by Messrs. Hering & Fuller also apply to this paragraph.

4. The power project cannot be regarded as an essential part of a general improvement scheme, because boulevards, parkways, permanent bridges, and so forth, were just as applicable to the original aqueduct as they are to the present development.

A. Wooden or trestle bridges would have been sufficient to give access to and from either side of the aqueduct. The construction of boulevards on either side of the aqueduct requires bridges of the ornamental type. Why not charge the difference in the cost of those bridges to the boulevards?

5. The present project has never been properly studied or reported upon as a whole.

A. The city engaged experts to report on the advisability of developing water power for its use. The following reports were made:

1854-57, Thomas C. Keefer advised the city to develop 600 h.p. at the cost of $500,000, or $833 per h.p.

According to Alderman William Rodden, in 1869: "It may be said in reference to such a proceeding, that whatever is expended on the new entrance and the reservoir may fairly be considered as part of a reliable project for future completion, and good value for the cost as far as it goes. Putting up a second engine should not be entertained hastily; all other available means should be first exhausted. With the rapids of the St. Lawrence at hand there should not be any further necessity for steam power."

In 1894, Messrs. Keefer & Vanier reported to the city: "Enough has been written to show that the aqueduct is, in every respect, a good property."

The city was to spend $1,500,000 to produce 3,000 h.p., or $500 per h.p.

In 1907, Messrs. Marceau & Kennedy reported that: "We are of the opinion that Mr. Janin's plan as thus outlined is entirely feasible, and also that it is an excellent one for improving the quality, increasing the quantity and reducing the cost of the city's water supply."

The estimate at the time was $2,200,000 for a water power of 3,000 h.p., or $733 per h.p.; it was not condemned.

In 1910, Messrs. Hering & Fuller stated: "Further, we desire to make it plain that the sound business basis for the enlarged aqueduct holds true regardless of whether the available water power is utilized for pumping water through the mains to the reservoirs of the city distribution system, or whether the power is used by the city for generating electricity or other purposes, or marketed in other ways than by its utilization for municipal requirements. This water power development is a sound practical business proposition on its own merits and there should be no concern felt on the part of taxpayers as to the wisdom of expenditures for this improvement."

The expenditure recommended was $7,000,000 for 10,000 h.p., or $700 per h.p.

These reports, some of them printed, were made public at the time; no criticisms were made.

"The generating of electricity by water power, and its transmission, has within the past twenty years completely revolutionized the aspect of power utilization, so that any report made twenty years ago is of no present value, regardless of the eminence of authors."

If the reports referred to were made by eminent engineers, and if they approved of the principle laid down by the city to build and operate its own power station, it must be said that "As the generating of electric energy by water power, and its transmission" has, since they made their reports, "Completely revolutionized the aspect of power utilization," the efficiency of water wheels, turbines and dynamos has increased in such a way that a development considered a good commercial proposition by them in the 90's would be a better proposition in 1916.

6. The project as designed would not safely develop under the best conditions more than 7,000 electrical horse power at any time of the year, and the average output would be actually much less than this.

A. Although Mr. Janin mentioned in one of his reports that 4,000 h.p. could be added for lighting purposes, he never mentioned electrical horse power. The original 5,000 h.p. was never admitted by him as being electrical horse power, nor was the 10,000 h.p., but he always spoke of it as hydraulical horse power. The 7,000 electrical horse power mentioned in the Ratepaying Engineers' Report, closely agrees with the 10,000 hydraulical h.p. mentioned by the late Mr. Janin, but to the man of no technical training, it looks like a big decrease in the original estimate.

A careful study of the hydraulic data sent to the Ratepaying Engineers, establishes the fact that, for a period of low water, or heavy back water, and taking into account the presence of two feet (2 ft.) submerged ice, some 12,000 hydraulical h.p. will be produced as a mean for that period.

"The velocity would be such that the bottom (of the tailrace) would be eroded, the retaining walls undermined and much other damage done."

I do not think a concrete floor would be so affected.

The summer power is found by the Ratepaying Engineers to be of 14,000 h.p., and as they refer to electrical h.p., this figure agrees very closely with that estimated by Mr. Janin.

The original section of the head race, which was to produce 5,000 h.p., according to Messrs. Marceau & Kennedy, was to be of 1,000 sq. ft. "Below the undersurface of the ice at low water."

The proposed section will be two and one-half times as great, the slope and head remaining the same, and the tailrace is enlarged proportionally with the same slope.

It is found now that, although the proposed enlargement provides for a section two and one-half times greater, a change in the lateral sides of the canal, which gives a better coefficient of discharge, will produce only 5,000 h.p.

The average monthly theoretical power produced during the low period, i.e., December, January, February, March and April, is found to be not less than 15,500, and not more than 20,500 for a period of nineteen years. The minimum power found was 13,400, and the maximum about 25,400, assuming two feet of submerged ice.

The summer period of seven months is found to produce nearly 100 per cent. more than the winter period.

The lowest winter power average of 15,500 hydraulical horse power is equal to 11,610 electrical horse power.

7. Serious operating troubles, due to frazil and other ice, are inevitable. These will greatly reduce the maximum output below 7,000 h.p. and may cause complete stoppage of the plant during a more or less protracted period every winter.

A. In their report of 1907, Messrs. Marceau & Kennedy stated in answer to the question: "Is frazil likely to interfere with the proper working of the proposed improvements?"

A. "The details of the works at the entrance of the aqueduct and the intake of the conduit are not yet fully worked out, but from the fact that the position of the present aqueduct intake is a very favorable one, and that no trouble has ever been experienced from frazil entering it, we are of opinion that the works can be so designed and built, that their operation will not be seriously interfered with by frazil."

The 13,000 h.p. represents approximately 9,750 electrical horse power, and for one day it will produce only 9,000 electrical horse power. The other days would give:

9,750 to 10,500 electrical horse power for 209 days.
10,500 to 11,250 electrical horse power for 410 days.

The day in which only 9,000 electrical horse power is found will probably be entirely eliminated by the construction of the breakwater, which will produce a greater head.

It may be fairly stated that for the winter months a minimum of 9,000 electrical horse power will be produced and that in summer it would be 18,000 h.p.

The yearly average on this basis would be 14,000 electrical horse power

8. The minimum capital cost of the project as designed will be $10,600,000. This cost is exclusive of the filtration works or any pumping plant or steam auxiliary plant, or the Cook Construction Company's claims for over $900,000, or an allowance for parking, or the usual allowance for contingencies.

A. The total value of the work done up to November 28th, 1916, is:

Filtration	$1,894,490.37	
Conduit	1,074,723.27	
Contract No. 1	773,783.70	
Contract No. 2	1,262,612.26	
Repairs to Conduit	33,840.99	
Pump, etc. (built in 1908-10)	72,137.99	
		$5,111,588.58

The above includes the work to be done to complete the filtration plant, percentages due to contractors, etc.

The work to be done to complete the enlargement is:

Cook Construction Co.	$2,060,947.48	
Bridges and Head Gates ...	660,000.00	
Power House	1,500,000.00	
Land to acquire	194,060.00	
Breakwater	475,000.00	
Fences and ditches	60,000.00	
Bond Street Wall	25,000.00	
Engineering	30,000.00	
		$5,005,007.48

Forming a Grand total of $10,116,596.06

The amount of accrued interest is $1,061,678.62

The amount of accrued interest during construction to the completion of the actual proposed work, would be $1,533,941.00

The total cost of the work will be:

Estimated value of work ...	$10,116,596.06	
Interest during construction.	1,533,941.00	
		$11,650,537.06

In subtracting from the above, the value of the filtration plant, the pump built in 1908-10, and the interest thereon, we have:

Value of work done	$3,184,960.12	
Interest	828,550.00	
		$4,013,510.12
Work to be done	$5,005,647.48	
Interest	576,000.00	
		$5,581,647.48
Or a total of		$9,595,157.60

Which includes the cost of the conduit and interest thereon; the usual allowance for contingencies included in the estimated value of each item; the cost of land required for boulevards, etc.

9. Radical changes in design at greatly increased cost would be necessary to even approximate the capacity of the power development as claimed by the city.

This has been answered under Conclusions "6" and "7."

10. The minimum capital cost based on the maximum safe capacity of the plant as designed will be $1,515 per horse power.

A. The capital cost would be $737 per horse power, if all items mentioned above were charged against the power development.

11. The minimum fixed charges and operating expenses for the power will amount to $757,000 per annum.

A. The fixed charges would be $479,800 per year, if capital engaged were taken as mentioned above. The rate of interest is estimated to be 5 per cent., which is the rate the city will have to pay.

12. The minimum fixed charges and operating expenses of the power plant will be $108 per horse power per annum.

A. The fixed charges and operating expenses will be $40 per horse power, taking into consideration the capital engaged as mentioned above.

The actual rates paid by the city are:

For 20 hours $20.00 per horse power.
For 24 hours $30.00 per horse power.

and

On a 2200 volt standby $10.00, 1½ to ½c. per kw.hr.
On a 550 volt standby $8.00, 1½ to ½c. per kw.hr.

13. Twenty-four-hour power can readily be purchased in the open market at a figure not exceeding $25 per horse power per annum, and twenty-hour power suitable for pumping for not more than $20.

A. Messrs. Marceau & Kennedy's report already mentioned, stated: "We are of the opinion that Mr. Janin's plan as thus outlined is entirely feasible, and also that it is an excellent one for improving the quality, increasing the quantity and reducing the cost of the city's water supply."

This report was made on the first enlargement. The total cost of the work was then estimated at $2,200,000, or $733 per water horse power.

Messrs. Hering & Fuller, referring to the same proposed 5,000 horse power development, approved of the work.

Electric energy was sold in 1907 and in 1910, but the city was not then advised to buy electric energy.

The cost of pumping the 100,000,000 gallons per day would be $877 per day, or $320,105 per year, taking as standard the DeLaval pump.

14. The yearly cost of purchasing the 7,000 horse power, which is the maximum amount of power that the project might develop, would not exceed $150,000.

A. The yearly cost of 3,000 electrical horse power would be, at the actual price paid for by the city, on the 24-hour rate, $90,000.

In his report of September 12th, 1916, Mr. Parent's estimates are based on the actual market prices for material and on the Fair Wage Schedule adopted by the city. It is known that these wages are higher than those paid by the Power Companies.

15. As compared with the purchase of power, this project, if and when completed, would involve a loss of at least $600,000 per annum.

A. The complete work would cost, including interest, $10,322,675.60, but would produce an average of 14,000 electrical horse power as compared with the 7,000 h.p. mentioned in the Ratepaying Engineers' Report.

The Ratepaying Engineers advise the city to stop all work in connection with the proposed work and buy the necessary power.

The capital thus engaged would be:

Work done and interest	$4,013,510.12	
Work to be done or payment to make:		
Bridges and fences	$ 300,000.00	
10% on balance of Cook Contract	203,640.00	
Power house and building to use the 7,000 h.p. purchased	340,000.00	
Construction of another conduit, or protection work, etc.	1,000,000.00	
		$5,857,150.12

Yearly charges would be:

5% on $5,857,150	$ 292,857.00	
Operation	18,000.00	
7,000 h.p. at $25	175,000.00	
Lighting, power, etc.	342,000.00	
		$827,857.00

The amount marked as lighting, power, etc., is the yearly cost to the city for the lighting of its streets and buildings, the power purchased, etc.

If the work is completed we have:

Capital on completed work and interest	$9,581,647.48	
Cost of street lighting system	1,680,000.00	
		$11,261,647.48

The yearly charges would be:

5% on $11,261,647.48	$ 563,082.35	
Operation and maintenance:		
Power house	45,000.00	
Lighting	152,000.00	
		$760,082.35
Annual charges as proposed by the Ratepaying Engineers	$ 827,857.00	
If work is completed	760,082.00	
Difference		$ 67,775.00

The yearly savings, if the work is completed, would be	$67,775.00
And the city could, with the proposed plant, sell 5,000 electrical horse power for seven months at $15 per horse power, or, per year	75,000.00

In completing the proposed work the city will economize $67,775.00 per year and own its street lighting system.

The city in selling an average of 5,000 electrical horse power per year, will receive per year $100,000.00

During the low period, when the power cannot produce the 14,000 h.p., the city will have to generate with the hydro-electric station 9,000 h.p. and the power required for pumping purposes will be produced by its steam plant.

The longest period in one year, when the 100,000,000 gallons will have to be pumped by steam, is 100 days. The cost of this pumping by steam would be, for the year $90,000.00

We have, therefore, the following comparisons:

Ratepaying Engineers' Proposal—		
Cost per year		$827,857.00
The proposed enlargement completed	$760,082.00	
Less 5,000 h.p. sold at $20	100,000.00	
	$660,082.00	
Plus cost of operating steam pumps 100 days	$90,000.00	
		$750,082.00
Difference		$77,775.00

The city will own its street lighting system and be independent of all power companies.

16. The present project should never have been started, and we are firmly of the opinion that all thought of completing it, along the present lines, should be abandoned.

A. Answered under Conclusion "15."

Conditions to be Met if the Project be Abandoned

17. If all work were to be stopped at once, the total capital cost to the city would be about $5,200,000, which includes an allowance of $300,000 for boulevards, bridges, fencing and cleaning up, but no allowance for the claim of the Cook Construction Company.

A. The claims for damages filed by the Cook Construction Company have not been mentioned, because they would be charged against either proposal.

18. The annual fixed charges on this amount of $5,200,000, will be $345,000.

A. Admitted.

19. The total yearly cost of 7,000 horse power purchased, plus the fixed charges on $5,200,000 would be $495,000.

A. The Ratepaying Engineers' proposition would cost the city $827,857 per year.

20. The total capital cost which will be saved by abandoning the present project will be a minimum of $5,400,000

A. It would cost more to the city if the Ratepaying Engineers' proposition were adopted, than if the city complete the enlargement and own its street lighting system; an excess of $70,000.

If it is found that a channel has to be dredged into the St. Lawrence, even half a mile long, it would not cost more than $50,000. The annual charges represented by this extra work would be only $2,500. The excess would be reduced to $67,500.

21. The total annual saving to the city by immediately abandoning the present project and purchasing 7,000 horse power would be a minimum of $262,000.

A. The answer to this conclusion has been given above.

22. By judicious adaptation of the existing conditions, a limited return may be derived from the expenditures already incurred.

A. This is possible.

Georgian Bay Canal

The effect of the construction of the Georgian Bay Canal on the proposed enlargement has been raised in certain quarters.

Whether the first section of the Georgian Bay Canal, mile 0 to mile 33 is built as part of the Georgian Bay route or as an adjunct to the Lachine Canal, it will benefit the proposed enlargement.

The elevation of the water level at the intake and that at the tailrace will be raised, but the head will be regular at all times.

The discharge will be increased and will produce, during the low period, 16,000 hydraulical horse power, and during the other seven months, 28,000 h.p.

The yearly average would be over 20,000 hydraulical h.p.

An Extensive Steel Plant at Toronto

A big steel plant is to be erected at Toronto, Ont., on the industrial area at Ashbridge's Bay. The undertaking is under the auspices of the Imperial Munitions Board, and the estimated expenditure is about $3,000,000. The plans are not yet quite ready. They include five buildings, one of which will be 300 ft. x 130 ft., with side clearance of 40 ft. for railroad tracks. Ten 6-ton, 3-phase, 25-cycle, Heroult type electric furnaces will be installed. Each furnace will consume about 2,000 h.p., which will be supplied by the Toronto Hydro-Electric Commission. The initial capacity of the plant will be 300 tons per day, and it will employ about 1,000 men. Modern dockage and railway facilities will be provided. Ultimately the plant will cover 60 acres. It is expected that work on excavation and pile-driving will be commenced at once, in order that manufacturing operations may be started in July. The staff of the Toronto Harbor Commission will supervise the construction work. The plant is to be exempted from taxation during the continuance of the war and for two years thereafter.

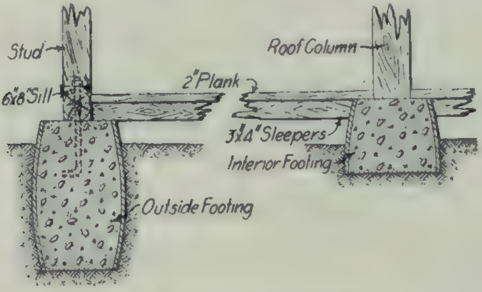
The average unit costs of pavements of various types in San Francisco for 1916 were: Asphalt, $1.91; bituminous rock, $2.14; basalt rock, $3.42; vitrified brick, $3.35.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Old Barrels Make Forms for Footings

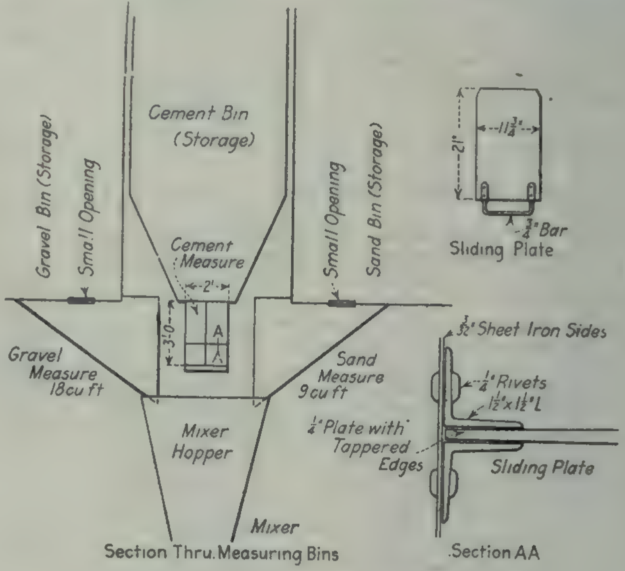
Time and expense were saved by using old oil barrels for footing forms recently in constructing a building for the Vacuum Oil Company at Rochester. The barrels used were 17 inches in diameter at the top and bottom, 19 inches at the centre, and 34 inches in depth. Around the outside of the building whole barrels were used, deeper footings being required to prevent movement from frost action. The forms for the interior footings were made by sawing the barrels in half at the bilge and placing the halves with the large end down. The interior footings are, of course, protected from frost action by the flooring. This method effected a great saving both in material and labor on the forms for these footings. As the barrels selected were old ones, they were left in the ground permanently.—Engineering Record.



Footing forms from barrels.

Measuring Device for Varying Concrete Proportions

On some concrete jobs several different mixes are often used, and in many cases it is frequently necessary to change from one to the other. The following article by a writer in Engineering and Contracting describes a satisfactory and economical method used in the erection of a concrete building where the nature of the work was such that it was necessary to change from one mix to another several times during the day's work. The mixtures were 1:1:2, 1:1½:3 and 1:2:4, consisting of Portland cement, sand and gravel, respectively. Sand and gravel were loaded in storage bins either side of the mixer hopper, as shown in the sketch, a mixer having a rated capacity of 32 cubic feet of loose material being used; the hopper, being stationary, was located a few feet below the bottoms of and between the two storage bins. Directly over the hopper and between the two bins for rock and gravel the cement bin was placed, with the measuring device attached to the bottom in such a way that the cement after being measured was released as wanted directly into the charging hopper of the mixer. The sand bin was provided with a measuring hopper holding 9 cubic feet of loose material and the gravel bin with one holding 18 cubic feet, each located so that after the material was measured it could be released by a lever operating a sliding door and would flow into the mixer hopper. The cement measuring device was arranged so that by a simple manipulation of blades 4½ cubic feet, 6 cubic feet or 9 cubic feet, as desired, of cement could be measured, the sand and rock bins being always held the same. Thus for a 1:1:2 mix the material measurements would be 9-9-18; for a 1:1½:3 mix the material measurements would be 6-9-18, and for a 1:2:4 mix the material measurements would be 4½-9-18. It will be noticed that the quantity of loose material in the 1:2:4 mix is about up to the capacity of the mixer and that the richer materials exceed the rated capacity. The specifications required that the sand and cement enter the mixer in advance of the stone, and due to the fact that the sand and cement were partially mixed before the gravel was admitted and that the gravel being admitted thus into a partially mixed material by the time the gravel was all in enough mixing had been done so that considerably more material could be added without overtaxing the capacity of the mixer. This proved out on the richer mixtures. Varying the measurement of cement was accomplished by having a box 24 x 18 x 36 in. high, as shown in the sketch, made of sheet iron 3/32 inch thick, with a partition vertically in the centre, making two vertical compartments each 12 by 18 by 36 in. Slots were provided in each of these compartments for three sliding plates 11¾ by 21 in., as shown in the sketch, one being at the top, one at the bottom and 1-1 ft. up from the bottom. By using one whole compartment thus made 4½ cubic feet of material was obtained; by using the upper 2 feet of both compartments 6 cubic feet was obtained, and by using all of both compartments 9 cubic feet was obtained.



Arrangement to vary concrete proportions at will.

Some trouble was anticipated with the cement arch-ing over the small opening, but by tapping on the sides with a hammer as the cement was being admitted this was avoided. In filling the measuring compartments, however, the air forced out as the cement entered carried considerable cement with it and made the plant operation unusually dusty. With this exception and some trouble in operating the sliding plates at first, due to their sticking in the grooves, the scheme was a success. Free movement of the plates was obtained by grinding the edges to a bevel on both sides, as shown in the sketch, section A-A.

Trade Publication

The Barrett Company have issued a booklet giving detailed descriptions of different types of Holt roof vent and leader connections and the purposes for which they are intended.

Mainly Constructional

East and West—From Coast to Coast

It is stated that the Canadian Northern Railway Company will begin the erection of their new station at Fort William, Ont., in April.

Last year in the eight months from May to December, inclusive, there was a total of 195 building permits issued in the city of Trail, B.C., at a value of $121,062.

Works Commissioner Harris of Toronto, recommends the laying of a sewer on the west side of the Don Esplanade from Eastern Avenue to Wilton Avenue, to cost $20,500.

The new municipal water system at West Vancouver, B.C., has now been completed. The bond issue for the work was $150,000, but the entire cost of the installation amounted to $120,231.44.

Beatty Bros., of Fergus, Ont., propose to establish a foundry in London, Ont., at Chelsea Green. The building to be erected will cost $30,000, and the firm will manufacture the metal parts of their iron pumps, barrel churns, grain grinders and hand and power washing machines. Hitherto they have bought their castings.

The Imperial Oil Company held the annual convention of the salesmen covering Quebec and the Lower Provinces on January 15-18 at the Ritz Carlton Hotel, Montreal. Mr. G. W. Mayer, vice-president, Toronto, presided. A sales convention has been held in Sarnia and others will be held in Calgary, Winnipeg and Vancouver.

The work of laying the pipes for the Maillardville, B.C., waterworks, now under construction, will be carried out by day labor, on the recommendation of Mr. F. L. Macpherson, Burnaby's municipal engineer, who has charge of the work. According to his estimate the work will cost about $233 and occupy about 16 working days.

The Northern Construction Company have started work on the construction of the wharf at James Island for the Canadian Explosives. Contracts for the iron, plain lumber, and the creosoted piles and lumber have been let to Wood, Vallance & Legget, More & Whittington, of Victoria, and the Vancouver Creosoting Company, respectively.

Preliminary work on the construction of a big graving dock capable of accommodating the largest ship which enters Vancouver harbor, has been commenced at the Wallace Shipyards, No. 2 yards at the foot of Bewick Avenue, North Vancouver. The dock will be built on the western side of the yard between Pembroke Avenue and Bewick Ave.

The Canadian Robert Dollar Company, Limited, announce that they have deposited with the Minister of Public Works at Ottawa and in the office of the District Registrar of the Land Registry District of Vancouver, a description of the site and plans of the wharf and sawmill buildings which they propose to build on the North Arm of Burrard Inlet.

Negotiations for a suitable site upon which to erect a modern manufactory have been under way for some time past between the Toronto Harbor Commissioners and the W. Harris Company, manufacturers of cases, glue and fertilizer. It is understood that plans for the new plant have been drawn up and that it is to be on the most up-to-date lines.

A resolution was recently passed by the Board of Trade of Nelson, B.C., that the government be urged to complete the transprovincial road from the prairies via Nelson-Rossland-Trail-Grand Forks-Keremeos - Princeton - Hope - Chilliwack-Vancouver, as soon as possible. Routes suggested east of Nelson are Hammill Creek, Crawford Bay and the Crow's Nest.

A delegation representing the Quebec members of the "Bonne Entente" waited on Lord Shaughnessy recently, and laid before him a request that an addition be made to the Chateau Frontenac at Quebec, the present accommodation being considered inadequate. It is understood that the delegation was favorably received and that the company will consider the advisability of enlarging the hotel.

Another railway construction corps, to be known as the 256th, has been authorized. One company will be raised in Montreal, another in Toronto, a third in Halifax and a fourth in St. Catharines. The corps will be commanded by Lieut.-Col. W. A. McConnell, and the Montreal company by Major F. L. C. Bond, eastern divisional engineer of the Grand Trunk Railway. All other officers will be chosen for their engineering qualifications.

Work on the additions to the Tyee smelter at Ladysmith, B.C., was recently commenced. Additional land adjoining the smelter property has been secured by the new owners and approximately $100,000 will be spent on new buildings, among these being a converter for the output of copper matte as well as blister copper. Hitherto the daily capacity of the smelter has been 600 tons, and it is the intention to increase this by 100 per cent. It is expected that the plant will be running within three months.

It is expected that work on the eastern section of the Trent Canal will be completed during the next three or four months, and the waterway from Lake Simcoe to Trenton on the Bay of Quinte will be opened for through traffic early next summer. The Severn River end of the project, giving outlet to Georgian Bay, will not be started until after the war. Practically all that remains to be done on the Trenton end of the canal is to complete a few locks and the bridges over the Grand Trunk Railway at Campbellford.

The special bridge supporting the 10-inch Montcalmville water main supplying the Belvedere Ward in the city of Quebec, collapsed recently during a storm. This bridge crosses the St. Charles River in the vicinity of Scott's bridge. Its fall caused the water main to break, and for a short time the residents of the ward were without water. With little delay, however, they were supplied from the Mount Pleasant Station through the 40-inch main. The bridge was comparatively new and was valued at between $5,000 and $6,000.

Plans for the expenditure of $125,000 for improvements to the General Public Hospital at St. John, N.B., have been approved by the Municipal Finance Committee and work will be undertaken this spring subject to the approval of the Council. The plans provide for the erection of a new building at a cost of $100,000, for use as Nurses' Home, with accommodation for fifty nurses, and the conversion of the present nurses' quarters into hospital wards, providing for fifty-eight more beds. A new wing costing $25,000 will be added to the main building, to contain 12 additional private rooms and a maternity ward.

At the inaugural meeting of the Essex Border Utilities Commission, held recently at Windsor, Ont., the plan for the joint water and sewerage system to serve Windsor, Walkerville, Ford City, Sandwich and Ojibway and the township of Sandwich West, as worked out by the board of engineers, was outlined. It is to cost approximately $3,000,000. It is recommended that a supply be secured from the head of Peche Island and filtered. This water system, it is estimated, will cost $1,900,000. The estimated expenditure on the sewerage system will be $881,000, with an additional $100,000 for a disposal system, which will be built near Ojibway.

In addressing the Ontario Motor League recently, Hon. Finlay Macdiarmid, Minister of Public Works and Highways for Ontario, stated that legislation will be introduced at the next session of the Legislature with a view to establishing a system of provincial highways. The details of the proposed plan have not been worked out, but it is understood that the Government will define certain roads as provincial highways and will itself undertake their construction on a permanent basis. For these highways the province will probably contribute about 70 per cent. of the total cost. The system, it is said, will include the proposed provincial highway from Windsor to the eastern boundary of the province, but every section of the province is to be linked up with a permanent highway, according to report.

At a meeting of the Executive Committee of the Eastern Ontario Good Roads Association, of which Major George Greer, of Cobourg, is chairman, it was decided to send a circular letter to every county, town and township council asking them to send delegates to Toronto on March 1 to present the matter of the Government assuming and maintaining the Kingston Road from Toronto to the eastern end of the province as a provincial highway. It is stated in the circular that enthusiastic approval has been given to the proposed improvement of the main highway from Toronto to the Quebec boundary, and it is felt by the Executive Committee of the provincial highway project that public opinion is strongly in favor of the undertaking. It is pointed out that a main highway from Toronto following the north shore of Lake Ontario and the St. Lawrence would link up the county and township road improvements now being carried out along the route and would be of great advantage to every municipality concerned.

That the Chatham, Ont., waterworks department has had a prosperous and progressive year is shown by the report recently presented by Secretary Weir. Water sales during the year amounted to $26,469.99, sale of meters and parts $1,487.02, fire hydrant rentals charged to city $6,180, which with various other amounts brought the total receipts up to $39,210.11. Operating expenses amounted to $12,538.86, being as follows: Fuel $3,552.07, salaries $6,143.63, sulphate of aluminum $1,545.21, and various smaller amounts. The maintenance expenses totalled $1,327.32 and extensions to plant and stock were made at a total expenditure of $5,960.04. The statement showed that the balance owing to the city on December 31, 1916, was $28,348.29, the reduction during the year amounting to about $1,300. The net receipts for the year were $25,343.93. A comparative statement showed that there had been an increase of $4,237.33 in water sales over the previous year, an increase of $458.55 in cost of fuel, an increase of $321.24 in operating expenses, decrease of $7.45 in maintenance, increase of $2,825.72 in extension to works, decrease of $637.25 in house service extensions, decrease of $404.49 in water meter sales, and an increase of $2,150.59 in cash balance in the bank.

In view of the policy of the city of Toronto, as proposed by Mayor Church, to discontinue during the war all unnecessary improvements, the Godson Contracting Company have written to the Mayor and Board of Control requesting that they be given a portion of the work hitherto carried out by the city by day labor. The company say that they are compelled to maintain the streets that they have laid during their guarantee period, but this will not neep them regularly employed, and they point out that they have to keep up their taxes and incidental expenses in connection with their plant. They also mention that prior to the war they had obtained 3½ acres of land on Union Street, just north of St. Clair Avenue, and sidings off the C. P. R. thereto, in anticipation of a large quantity of civic work in the northwestern section of the city. They suggest that this would be a desirable location to erect temporary buildings for munitions or other war purposes and offer the city or government the use of about two acres for a nominal rent and taxes, pending the resumption of local improvement work. As well, they offer to construct anything that may be required on this property for war purposes that may be possible for them to do, covering only the wage cost and sufficient to cover charges necessary for upkeep.

Personal

At the inaugural meeting of the Essex Border Utilities Commission, Mr. Gordon McGregor was elected chairman and Mr. T. C. Ray, secretary.

Lieut. L. W. Klingner, of the 10th Field Company, Canadian Engineers, has been awarded the Military Cross for bravery on the field under heavy fire. Lieut. Klingner is a graduate of the Faculty of Applied Science and Engineering of the University of Toronto.

Major L. C. Thomson, railway contractor, has been appointed recruiting officer in Montreal of the 257th Railway Construction Battalion, being raised by Lieut.-Col. L. T. Martin. Major Thomson has been engaged in railway construction work in the Maritime Provinces, Quebec and Ontario.

Mr. John McIntyre, L.R.I.B.A., was recently married to Miss Jeanette Marian Julia Peele, eldest daughter of the late Capt. and Mrs. A. Peele, of New Westminster. Mr. McIntyre came from Scotland, where he had a consulting practice. He now holds the position of engineering draughtsman for Point Grey municipality. He formerly held a similar position in the municipal hall, Vancouver.

Obituary

Signor C. Mariotti, president of the Mariotti Marble Company, Montreal, died suddenly from heart failure on January 9, aged 74. He was former consular agent for Italy in Montreal. Signor Mariotti was an expert sculptor, and established the marble business of which he was head. He supplied marble work for many large buildings throughout Canada.

Mr. Thomas Malcolm, well known as a railway contractor in the East, died on January 10 at Campbellton, N.B., after a long illness. He built the Temiscouta Railway from Riviere du Loup to the head of the St. John River, but his principal work was the line from Campbellton to St. Leonards on the St. John River, a distance of 110 miles, and known as the International line. It now forms part of the Dominion Government railways.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 January 31, 1917 No. 5

Principal Contents

Page
Editorial ... 89
The Canadian Arsenal at Lindsay ... 91
Vancouver's Big, New Creosoting Plant ... 93
Pure Water and the Public Health ... 96
Government Ownership and Management of Railways Severely Condemned ... 98
Retiring President of Montreal Builders' Exchange Reviews Past Year's Work ... 100
Canadian Society of Civil Engineers' Annual Meeting .. 103
Mainly Constructional ... 108

A Need for Small Houses

AT a recent meeting of the Montreal Real Estate Exchange, the members discussed conditions in the real estate and building situation, which, they declare, call for action on the part of building contractors in that city. There is apparently a strong demand for housing accommodation which for some reason is not being met by the builders. Montreal can hardly be said to have suffered financially or commercially by the war, and there should be no tightness of money; indeed, the munitions industry and various other classes of war work have created more favorable business conditions in Eastern Canada than had existed for some time before the start of hostilities, and yet building operations seem to have declined. Mr. J. V. Desaulnier told the members of the Exchange that $27,000,000 had been spent on construction work in Montreal in 1913, whereas last year the amount was $6,000,000. In 1913, he said, building permits were issued for nearly 5,000 dwellings and tenements, while in 1916 less than 1,200 were applied for, a number not equal to the year's marriages. Construction was not, therefore, keeping pace with the needs of the situation. He consequently urged the immediate erection of a large number of moderate-priced houses in outside districts, where there is plenty of space, sun and fresh air, to sell at from $1,000 to $3,000. Mr. U. H. Dandurand, the chairman of the Housing Committee of the City Improvement League, also emphasized this shortage of dwellings for the working classes. He stated that while 35,000 men, mostly unmarried and living in boarding houses, had left the city for overseas service, in their places tens of thousands of men with their families had come into Montreal from the country to work on munitions, with the result that whole blocks that were empty in 1914 were now not only filled, but had a waiting list, and rents were rapidly increasing.

* * *

Similar conditions to these have been met with in other Canadian cities and towns, and in some cases contractors, perhaps, are not alive to the situation. Many builders, no doubt, feel that it is merely a spasmodic demand for dwellings to rent and that after the war, when numerous workmen who have gathered to the munition plants in the cities return to the country or to the smaller towns, the houses will be left empty on their hands with no opportunity for profitable sale. However, they should not forget that when the war is over there will be thousands of soldiers returning from the front, while it is expected that there will also be a great influx of foreigners, who will fly from the desolation of Europe to find shelter on this side of the Atlantic. This point was emphasized by Mr. Dandurand, who predicted a great shortage of housing accommodation after the war, unless steps were taken to relieve the situation. His advice to the builders was that they should erect low-priced houses, as munition workers now earning $7 a day might receive only $2 a day after the war, and would be obliged to live more humbly.

* * *

Another member of the Exchange, Mr. Jos. Versailles, offered an interesting suggestion that there be a competition among architects for plans of good houses for small holders, selling at from $1,000 to $2,400. These would be supplied free of charge to all buyers of land, and the architects' agreement could be printed on the back of each plan. We believe this idea is worthy of consideration, and that a situation such as has arisen in Montreal can be handled more efficiently by the co-operation of both architect and contractor.

Pure Water and the Public Health

WE publish in this issue some extracts from an excellent paper by Mr. George A. Johnson, of New York, on the subject of pure water and its influence on public health. The importance of supplying pure water is quite as great in Canada as it is in the United States. Outbreaks of typhoid of serious proportions have occurred in this country and apparently the experiences passed through by some of the cities concerned do not seem to have produced a lasting effect on the governing authorities.

The report of the International Joint Commission contains abundant evidence of this.

Water is being drawn to-day from sources which have caused acute outbreaks of typhoid, and such an attitude on the part of public authorities is incomprehensible. Sickness, deaths, and disastrous losses which could be avoided by the application of modern equipment denote either callousness on the part of the administration chosen by the people or an entire lack of appreciation on the part of the public of the true functions of public service. Water should be pure. It should be the medium by which health is preserved, and not jeopardized. Medical men tell us frankly of its possibilities for making inroads on their income. Fatalistic ideas belong to the dark ages, when people knew nothing about the causes of "bowel troubles," but to-day, when it has been proved beyond question that impure water is productive of catastrophic results, it is difficult to understand why the consumers continue to tolerate the position and endure the suffering and sorrows. Once an epidemic has been stamped out at great expense, how often do we see the public recover from its nervous agitation and quietly resume its former attitude of relative indifference and unpreparedness against further attacks. When epidemics recur the agitation is again rife, only once more to succumb to the seductive influence of a false idea of economy, or to the promise that the conditions will be remedied—by an inadequate precautionary measure.

The pollution of water supply is often intermittent, and this is one source of pronounced danger. The International Joint Commission referred to "the intermittency of serious pollution wherein lies the great menace to water supplies." It also stated that "it is a well-known fact that disaster on a large scale may be the result of pollution which occurs at infrequent intervals." It is precisely such conditions that have to be guarded against. It will avail nothing to wring one's hands in anguish when the disaster is upon us, and declare with thankfulness that such a thing seldom occurs, or declare that it should not occur, and that the culpability of the transgressors should be exposed and punished. The remedy lies with the public, for the administrators are what the people require—aggressive or complacent, progressive or retrogressive, good, bad, or indifferent. If the public insists on efficiency it will get it, but if it is satisfied with a lackadaisical method of administration, that also will be forthcoming, with its inevitable dire consequences. Bananas cannot be grown on cabbage stalks nor can a high standard of public health be established on an impure water supply. Mr. Johnson does well in directing attention to the value of pure water, and we commend his article to the consideration of those who have water supplies under their control.

Regina Branch, C.S.C.E. Extends Activities

The Regina Branch of the Canadian Society of Civil Engineers recently held an important reorganization meeting at which it was decided to take steps to extend the scope of this branch so that it shall include all members of the engineers in the province of Saskatchewan. The same steps were taken some little time ago in the province of Manitoba. The secretary of the Regina Branch has furnished the following report of this meeting:—

"It has been felt for some time by the members of the Canadian Society of Civil Engineers residing in Saskatchewan, that a closer co-operation is necessary, also a centre for the profession of easier access to them than the headquarters of the parent society which is at Montreal. With the unanimous consent of all members in this province it is suggested to extend the scope of the Regina Branch of the Canadian Society of Civil Engineers to include all members of the engineering profession in Saskatchewan and change the name to read "Saskatchewan Branch."

"An organizing meeting was held at Regina, which elected Messrs. L. A. Thornton and J. N. deStein, as chairman and secretary respectively, pro tem; a Nominating and Organizing Committee of five was also elected, including Messrs. L. A. Thornton and H. S. Carpenter, Regina; G. D. Mackie, Moose Jaw; C. J. Yorath, Saskatoon, and R. W. Ross, Melville. This committee will convene in the very near future, at which time the future organization and the outlines of the general policy of this Branch will be fully decided upon, after sanction of the Council of the parent society at Montreal has been obtained."

Munitions Industry Growing

Some idea of the tremendous growth of the munitions industry and war work in Canada may be gathered from statements recently made by Mr. J. W. Flavelle, chairman of the Imperial Munitions Board, in a speech before the Women's Canadian Club. Authorized expenditures, he said, including those already made, totalled $200,000,000, and operations had been carried out in 600 factories, located in every province with the exception of Prince Edward Island. Over 400,000 men and women were enaged in these factories. He also added: "We are, at the moment, constructing factories for the manufacture of various munitions. One, commenced a few weeks ago, will cost $2,250,000, and another we hope to complete in thirty days, using 900 men in the building, will cost about $2,000,000. Another we decided to erect a few days ago, and which we hope to complete by midsummer, is estimated to cost $1,750,000. A series of factories in connection with the proposed establishment of airoplanes will entail an expenditure of between ten and fifteen millions."

The Engineer's Future

Mr. N. D. Baker, Secretary of War for the United States, in a recent address, stated his belief that engineers are going to be a vastly important factor in industrial and commercial undertakings in the next eight or twelve years. The following sentence or two from his address shows the important position which he believes engineers will occupy: "The engineer is going to take his place alongside of the politician in making possible the vast extension of activity in our country. I find in my observations in the War Department that war is becoming more dependent on engineering than on the contributions of any other science."

The Joint Committee of Technical Organizations (Ontario Branch) is sending out letters to some 2,000 technical men, explaining in detail the organization and the aims of the committee. Every technical man in the Province of Ontario who does not receive such a letter during the week ending Feb. 3 is requested to communicate immediately with the secretary, Room 910, Excelsior Life Building, Toronto.

The Canadian Arsenal at Lindsay

Will be a Permanent Source of Supply for Rifle Ammunition—Work Proceeding Rapidly—Construction Methods.

THE small arms ammunition factory at Lindsay, Ont., is to be for the Dominion of Canada a permanent source of supply of rifle ammunition of dependable quality. It is designed and will be equipped to manufacture 300,000 British .303 rifle cartridges in ten hours.

The Lindsay arsenal is an aggregation of a large number of separate buildings housing a great variety of complicated manufacturing equipment, all so closely co-related in point of physical proximity, design, and equipment as to become a complete unit, no function of which could have been treated separately from the others without seriously jeopardizing economy of time, cost of construction, and efficiency of manufacturing processes.

Routing Carefully Studied.

In the general plan of building layout the routing of material was carefully studied from a purely manufacturing standpoint to insure a minimum of handling. The type, plan, and general dimensions of buildings were considered in their relation to the manufacturing equipment. Several important details which influenced the designs were: The stresses set up by the power transmission; the determination of the amount and location of glazed window areas in order to provide the most desirable lighting and ventilating conditions with the maximum economy of lighting, heating, and ventilating; and the peculiar hazards involved in buildings where explosives are stored and handled.

The manufacturing equipment involved the purchase and installation of over 500 pieces of machinery, which are in the main of a highly special nature, complicated in design and varied in type and function. The powering of these machines and their location in relation to raw materials and to one another was studied most carefully.

The arsenal buildings are divided into four groups on the one-hundred-acre plot. The fourteen buildings comprising the main manufacturing group are located in the northwest corner of the plot. These buildings, lying parallel to each other, are connected at their east ends by a passageway, which gives access to all buildings. This group includes a two-storey brick office building, 40 x 90 ft.; a brass foundry, 70 x 80 ft.; a rolling-mill, 70 x 200 ft.; a case plant, 80 x 300 ft.; a bullet plant, 60 x 300 ft.; a machine shop and tool room, 42 x 300 ft.; a case and bullet inspection building, 50 x 165 ft.; a carpenter shop, 42 x 150 ft; a gas plant, 42 x 78 ft.; a boiler house, 42 x 55 ft.; a storehouse, 50 x 100 ft.; and a transformer station.

With the exception of the office building, storehouse, and case and bullet inspection building, all these buildings are of steel frame construction. The office building has hollow tile walls, with tapestry brick facing, wood floor joists and studding, and is plastered throughout. In this building Superintendent Lieut.-Col. S. S. Weatherbie, with his assistants, clerks, draftsmen, etc., have their offices. Here are also the chemical and mechanical laboratories, testing rooms, a first aid ward, and a library and lecture room. A two-storey fireproof vault, for the books, records, and drawings, is located in one corner of this building. The storehouse and the case and bullet inspection buildings are of one storey, with hollow tile walls, wood posts and roof framing and steel sash. The inspection building has a wood floor on a tar Rok base.

Uniformity of Truss Design.

The main manufacturing buildings are one-storey steel frame, with hollow tile walls, steel sash, and concrete roofs. Only two designs have been used in the steel frames—one a forty-foot truss, the other a fifty-foot truss on steel columns spaced nineteen feet on centres. The steel contract was awarded on a pound price basis, and the steel work was then detailed so that the material which Canadian yards had in stock could be used as far as possible. The use of trusses of the same design in several buildings simplified the detailing and shopwork and resulted in remarkably quick shipment considering present market conditions. The boiler house and the rolling mill are floored with paving brick, with the excepfion of the space around the annealing furnaces in the latter, where cast iron plates set in concrete are used because of the handling of trucks of hot metal in these sections. In the gas plant and in all buildings where wet conditions of manufacturing are encountered the floors are of concrete pitched to drains. All other floors are of hemlock underflooring, with maple wearing surface on a tar Rok base.

The steel sash used in the side walls are continuous between columns, and extend from the concrete sill at the top of the five-foot base wall to the eaves purlin. Monitor sash are also continuous between truss posts, and are about five feet high. All ventilating units in these sash are operated by a straight push operator in runs of approximately 150 feet between operating stations. All sash are glazed with factory ribbed glass, with ribbed wire glass in the vents. The roofing for all buildings is five-ply Barrett Specification.

The Loading and Magazine Group.

The nine buildings of the loading group are about one thousand feet east of the main manufacturing buildings. They are all small buildings, ranging in size from 16 x 26 feet to 29 x 99 feet, and are connected by a passageway through which all materials may be handled unimpeded by weather conditions. They have tile walls, steel sash, mastic asphalt or special flash-proof composition floors on a concrete base, and roofs of concrete or light wood framing. Toilet rooms and coat rooms are provided opening off the passageway, and are of similar construction to the other buildings. These buildings are separated from the main group because of the dangerous operation carried on.

The eight buildings constituting the magazine group are situated about six hundred feet south of the loading buildings. They are of tile construction, with light wood roofs and non-gritty asphalt floors. Earth embankments eight feet in height surround each magazine building. This type of protection is also used around the loading buildings where quantities of explosives are in use or in storage.

The fourth group includes a rifle range and an ordnance inspection and stores building, where the final inspection is given to the cartridges, and where they are packed and stored for shipment. The rifle range, housing both a 600-yard and a 60-yard range, is a concrete structure built below ground. The 600-yard range is a 6 x 7 foot reinforced concrete tunnel, curved to follow the trajectory of a bullet and having pockets at the side for target setting every hundred yards, and a target house at the east end. The 60-yard range is 2½ feet wide by 7 feet high, and of similar construction to the 600-yard range, and having two side pockets and a target house. The firing house is a reinforced concrete structure about 25 feet square, the floor of which is seven feet below grade; the walls are thoroughly waterproofed with membrane waterproofing and are lined inside with hollow tile. There are four rooms in the building—one firing room for each range, one instrument room, and a store room. Conduits are laid in the concrete walls of the range for telephones, instrument wiring, and electric lighting. Ventilation of the range is provided for by spacing louvers at intervals along each wall, while a suction fan is installed to dispose of the gases from the firing.

Ordnance Building.

The ordnance inspection and stores building is of similar construction to the case and bullet inspection building, but is about 100 feet longer. The storehouse portion is separated from the inspection by a fire wall. Cartridge boxes are handled in this storehouse by an overhead telpher, which also hoists them to the shipping platform.

A system of asphalt roads and concrete walkways connects the various buildings and the several groups. The roof of the rifle range provides a runway for the electric trucks operating from the main manufacturing buildings group to the loading buildings. Two railroad sidings and a crossover give a length of 5,000 feet of siding at the plant, with a 100-ton track scale near the point at which the track enters the grounds, thus allowing the ready weighing of both incoming and outgoing materials.

Construction Methods.

In erecting the steel work for the plant the small size of the buildings and the uniformity of the trusses made assembly comparatively simple. The trusses were transported to the site completely fabricated and assembled, and they were erected by means of an ordinary wood derrick, working on temporary rails. Poling was resorted to in only a few instances. The details of the operation were so simple that no unusual or special methods were devised. For pouring the concrete roof slabs a large tower and chutes were employed, the tower being in the neighborhood of 225 feet high. Two towers were built, although it developed that only one was needed. This tower was used, in addition, to feed a screen beside it, which separated the sand from the gravel, the latter having been found to run rather high in sand. The one tower had sufficient radius of action to cover almost the entire plant, with the exception of some outlying or isolated jobs. The centering for the roof slabs was made in units in the shop, according to the plans of the roof layout, this being possible on account of the uniformity of truss and girder spacing. These forms were well oiled before use, and were employed over again from three to four times.

The excavation was, in the main, carried out by trenching machines. The foundations were plain walls, without spread footings, so that the side walls of the trench made forms for the concrete. The quality of the clay was such as to prevent any appreciable sloughing. The trenching machine was also used to excavate the range tunnel, the machine digging the core as well as the side trenches. It was the intention to use the earth walls as side forms for the concrete, and, although this was done in part, the rains caused washing, which necessitated separate form work.

Heat, Light, and Power.

The buildings are heated by direct radiation, making use of the Webster vacuum system. Wall radiation has been used throughout. A central boiler plant, consisting of four 150 horse power horizontal return tubular boilers, furnishes steam at 100 pounds pressure for heating and manufacturing purposes, this pressure being reduced at the several buildings to five pounds for heating purposes. Electric power is supplied by the Hydro-Electric Power Commission at 4,000 volts, 3-phase, 60-cycle, and is converted in the arsenal substation to 550 volts for power wiring and 220-110 volts for lighting. The lighting of all buildings has been carefully studied in relation to the machinery layout. In the loading building extra precautions, including vapor-proof fixtures, were employed to meet the dangerous conditions existing. Direct current is to be supplied for charging motor trucks, instrument batteries, and batteries for electrolytic work in the laboratory.

Ten toilet units have been installed, so located as to be most accessible. Automatic flushing waterclosets and stall urinals have been adopted, and the lavatories are the barrack room type, in enamelled iron. Fire protection is provided in the yards by means of three-way hose hydrants and hose-houses, with full equipment of hose, nozzles, wrenches, axes, and crowbars. Portable hose-reels, containing 1,000 feet of hose, are located near each group of buildings. Hose outlets are provided in the buildings, with reels containing 100 feet of 2½-in. linen hose. Small hand fire extinguishers are placed in all buildings.

Anthracite Producers Used.

The brass foundry will contain forty fires in one battery, ten of which are to be used for cupro-nickel and the remainder for brass. Square fires were adopted, as coke only is used in firing. A 5 ft. x 150 ft. steel stack, lined with fire-brick to the top, provides ample draft. A direct motor-driven alligator shear is placed in the foundry to cut up copper pig and scrap metal. A convenient scale is provided to weigh out charges.

The gas plant is equipped with three anthracite producers, having a capacity of 115,000 cubic feet of gas per hour. Hot gas from two of the producers is used in the large annealing furnaces in the rolling mill without scrubbing, but the gas from the third producer is scrubbed, as this gas is used in the case-annealing and the tempering furnaces.

The rolling mill is equipped with one direct motor-driven alligator shear and one small trimming shear. A weighing scale is convenient for weighing trucks of metal for checking. There are two annealing furnaces or muffles, one single and one twin, and both are double-end. They are under-fired, using hot producer gas. The mills are made up of two stands, one breaking down and one finishing, direct-driven through herringbone gears by a 250 horse power motor. The usual immersing, pickling, and washing tanks are installed. In the rolling mill are also installed the first cupping presses for both cupro-nickel and brass.

Machinery Arranged for Minimum Handling.

The bullet plant houses all of the special bullet machinery. These machines are arranged so that the flow of material is always progressing toward the inspection end. The lead extrusion press and equipment are also housed in this building. An aluminum extrusion press ordered for the Quebec arsenal was made over into a lead extrusion press to make six reels of lead wire at one time.

The case plant contains all of the special machines with which to make the complete brass cartridge cases. This machinery is likewise laid out for straight-line operation with minimum trucking.

The transmission equipment is of the latest type, employing a special hanger with turned plungers and using ball bearings. The shafting is turned and ground. The group drive system is employed.

The case washing plant equipment consists of fifty tumbling barrels for case washing, five special gas-fired annealing furnaces, and four case dryers, using indirect steam heat. Hot water and soap solutions are provided from overhead tanks. Overhead mono-rail systems for handling case to and from the annealing furnaces and into the immersion tanks are installed. All floors in this department are drained.

Canadian-made Tools Used.

The tool and machine shop are housed in one building, the tool room at one end and the machine shop at the other, with the tempering and grinding rooms between. Both equipments are complete in every respect, including the latest types of machine tool equipment, in the main furnished by Canadian manufacturers. Gas-fired tempering furnaces are installed. A small blacksmith shop and pipe shop is housed in a separate building. This shop is equipped with a motor-driven pipe machine to cut up to 8-inch pipe, two down-draft forges, and a power hammer.

The carpenter shop for the manufacture of ammunition boxes, work boxes, etc., is equipped with the latest design of direct-driven woodworking tools. The shop has a capacity of 300 ammunition boxes per day. In connection with this shop is a complete tinsmith's equipment, with which to line the ammunition boxes with the usual waterproof lining of tin.

The equipment of the loading and assembling plants requires highly special equipment, which is arranged for group drive. All of this equipment is thoroughly grounded, to avoid explosions due to sparks from either induced or static currents. The drying of fulminate of mercury and potassium chlorate—always a dangerous operation—will be done at the Lindsay arsenal by means of vacuum driers, which perform their work efficiently and quickly, and reduce to a minimum the danger from explosion of these substances.

The elevating hand-truck system will be used in handling the majority of the materials in each unit. Between the manufacturing and loading buildings storage battery tractors will be employed, each capable of hauling several trailers and of operating ten hours continuously without recharging. Both the electric tractors and elevating trucks are recent developments by Canadian manufacturers.

Lightning Protection.

Much study was devoted to the lightning protection of the magazines, loading, and fulminate buildings. High steel poles similar to flagpoles are placed at the side of each building, extending down deep into the earth, to assure good ground connection. The lightning poles are about thirty feet higher than the building. To collect any leakage of lightning, short, stout lightning rods are placed on the highest point of each building. All metal in the building, including machines, shafting, structural steel, etc., is connected in a loop or ring and thoroughly grounded, top and bottom.

Materials and machinery of Canadian manufacture were in every case given preference for this work, and only such products as could not be obtained in Canada were purchased in the United States.

Personnel.

Lieut.-Col. A. P. Deroche, R.C.E., Director of Works and Buildings, is in charge of the building work for the Militia Department, assisted by Mr. Clarence Noble, Supervising Engineer. Lieut.-Col. S. S. Weatherbee, of the Militia Department, as superintendent of the plant, is the engineer in charge of the manufacturing equipment. Under the direction of this staff the engineering, architectural, and construction work was performed by Westinghouse, Church, Kerr & Co., with offices in Montreal and New York.

The information in this article was furnished by Westinghouse, Church, Kerr & Co.

Vancouver's Big New Creosoting Plant

On the first of November, 1916, the Vancouver Creosoting Company, Ltd., commenced creosoting operations at its new $300,000 plant at North Vancouver, across Burrard Inlet from the C.P.R. depot, on which construction work commenced in February. The property of the company covers a total of twenty-eight acres—twelve acres of reclaimed ground, with the north end of the property abutting on the right of way of the Pacific Great Eastern Railway, and sixteen acres in the booming area, for receiving and sorting of piling and lumber and storage of treated material. The extreme length of the plant is over half a mile. A creosoted piling wharf, with three mooring dolphins, is located at deep water, and is connected with the plant proper by a creosoted pile approach a quarter of a mile long. Ships of any draught that come to Vancouver harbor can be accommodated at the wharf end, so that creosote oil can be received in tank ships and piped through an 8-in. pipeline extending from the wharf along the approach and into the main storage tank in the plant, which tank has a capacity of three-quarters of a million gallons. There are three other creosote oil tanks, bringing the total capacity up to one million gallons.

The main treating plant consists of two of the largest creosoting retorts on the continent. They are 7 ft. inside diameter and 132 ft. in length, and are made of ¾-in. steel plates, with an immense steel door located on one end of each retort. Above the two creosoting retorts, and at right angles to them, are two 70-ft. cylinders of similar construction to the retorts, these being used in one of the special creosoting processes used by this company. The creosoting retorts are surmounted by steel vapor drums, and above these latter are located the steel condensers and the steel drip tanks.

The buildings are mill construction, and covered with galvanized iron. Creosoted products have been used wherever necessary in the construction of the plant. All the piling, lagging, and chinking in the bulkheads, the approach wharf and booming area, ties in all the tracks, the butts of poles for the light and power wires, and the wood sills in the timber structure were creosoted. Creosoted wood conduit was used for underground cable installations, and creosoted wood paving blocks are laid in the floor in the boiler house.

A complete chemical laboratory for the chemical analysis of creosote oil, moisture determinations on wood, etc., is part of the regular plant equipment. The apparatus, etc., for the laboratory was supplied by the British Columbia Chemical and Assay Company, of Vancouver. The latest and most up-to-date methods of recording pressures, vacuums, and temperatures have been installed, the instruments having been supplied by Messrs. Frank Darling & Company, of Vancouver. These instruments give accurate readings of temperatures, pressures, etc., for every minute during the treatment.

In the operation of the plant, piling and lumber on scows, or cars, or in cribs are unloaded and sorted in the booming area. The piles are then towed to the saw float, where the points and butts are trimmed up and the piles cut to length. They are then lifted out of the water by either a stiff-leg derrick or a locomotive crane, and carried by the latter to the storage yard, where they are placed in stacks according to their lengths. When they are required for creosoting they are loaded on steel retort cars and pulled on the tracks to the retorts. The big steel doors are then closed by means of forty-eight 2¼-in. diameter steel bolts. The retorts are then filled with creosote oil, which flows by gravity from an elevated steel working tank, and steam is circulated through pipe coils in the bottom of the retorts and under the car tracks, the temperature of the oil being thus raised to from 190 deg. to 240 deg. F. This part of the process boils out of the wood the free sap and moisture, which, being lighter than the creosote, rises through the latter and escapes from the retorts into the vapor drums above, and from there through the condensers and thence to the drip tanks and finally to a sump tank.

As soon as the piling is seasoned to the required moisture content the temperature is reduced to about 180 to 190 deg. F., additional oil is pumped into the retorts, the outlets from the retorts into the vapor drums having been previously closed by means of valves and a creosote oil pressure of from 130 to 160 pounds is exerted. During this pressure period the contract quantity of creosote oil is forced into the wood. The boiling or seasoning occupies anywhere from eighteen to forty-eight hours, depending upon the condition of the green material, and the pressing occupies from two to six hours. Piling is penetrated by the oil to an extent of ¾ in. or more, and about 12 pounds of creosote is left in each cubic foot of wood.

In a new process used by this company the boiling or seasoning part of the process is hastened and materially assisted under a much lower temperature by boiling under a vacuum of 20 in. to 24 in.

The company is creosoting piling in any lengths up to 132 ft., timber, piles, ties, paving blocks, crossarms, wood pile, wood conduit for underground cables, etc. From 2,500 to 5,000 lin. ft. of piling can be treated at this plant per 24-hour day, and from 50,000 to 100,000 ft. b.m. of lumber or ties. The creosoted piling market is a local one, while the market for ties, lumber, and other wood products is practically worldwide.

The plant is laid out so that the capacity can be doubled in a short time and without interfering with the operation of the present equipment. The paving block mill for sawing blocks has not been installed as yet, but the plans and bills of material are all ready, so that, should a sufficient volume of this business be secured, equipment can be promptly secured and installed.

In every case where it has been possible to use British Columbia materials or firms this has been done. Any machinery not locally made was ordered through local concerns, except in a few instances where certain special equipment was not handled by local agents. The following are the contracts as let: The creosoted piling, bulkheads, approach, and wharf were driven and built by Palmer Brothers & Henning, and the dredging and filling done by the Pacific Dredging Company, who sublet a portion of it to the Vancouver Dredging and Salvage Company. Lumber for the construction of the buildings, etc., was furnished by the Hastings Saw Mill and the Vancouver Lumber Company. The steel storage tanks were built by the Dominion Iron Works, A. J. MacDonald, and J. F. Ferris, of Vancouver. The boilers and cast steel retort car arms were furnished by the Vancouver Engineering Works. The retorts, vapor drums, condensers, drip tanks, measuring tanks, and fuel oil tanks were all made by the Ross & Howard Iron Works. The conveyor equipment, drag saws,

Two views of creosoting plant, showing oil tank on the left and storage yard on the right.

and retort cars were built by the British Columbia Equipment Company, who sublet the construction of the retort cars to J. Coughlan & Sons, who also furnished the structural steel supports for the condensers and drip tanks. Pumps were bought through the British Columbia Equipment Company and the compressor from the Canadian Rand Company, Ltd. Motors were furnished by the Canadian General Electric Company, Ltd., and the electrical supplies were bought from the Northern Electric Company, Ltd., of Vancouver. Nitrogen filled lamps in special fixtures are used, and were furnished by the Western Electric Company, Ltd. Two wood water tanks were bought, through Langley & Hazlitt, of Vancouver, from the Pacific Wood Pipe Company, who also furnished the wood pipe water mains. Rails were bought from Newson, Keen & Townley, of Vancouver. Some of the first steel rolled by the Port Moody Steel Works was used for concrete reinforcing, and the cement was furnished by Messrs. R. V. Winch & Co. and Balfour, Guthrie & Co., which latter firm also furnished the bolts and steel rods used throughout the plant. Other miscellaneous materials were bought from Messrs. Evans, Coleman & Evans, Ltd., miscellaneous castings in considerable quantity from the North Shore Iron Works, and machine work by the Wallace Shipyards, Ltd.

Quebec Association of Architects Hold Annual Meeting

Members of the Province of Quebec Association of Architects held their annual meeting on January 13, at the rooms of the association, Beaver Hall Hill, Montreal. In the absence of Mr. E. B. Staveley, the president, the chair was occupied by Mr. Hugh Vallance, first vice-president.

The annual report of the council was presented by the chairman. This referred to the deaths during the year of Mr. F. X. Berlinguet, one of the founders of the association, and Mr. Gordon Blackader, killed in action. The question of amending the charter had been considered by the legal committee, the object being to render it more explicit, and thus to do away with any more adverse decisions by the courts, as had happened lately in the Court of Reviews. Amendments to the charter were presented to the Quebec Legislature at its last sitting, and were adopted after some modifications which were found acceptable under the circumstances. The committee believed that the association at last would be a closed one, such as those pertaining to lawyers, notaries, doctors, etc. The committee on quantity surveying had considered the question of introducing this system into the Province of Quebec. The committee, after collecting data from various sources, was of opinion that there were two principal difficulties to contend with before a system could be put into operation. The first was the matter of getting the contractors to act unanimously, as a great divergence of opinion had been expressed by those who had been approached. The second was establishing a competent and responsible board of quantity surveyors to properly handle the amount of work that would be involved. The incoming committee should continue the study of the question and endeavor to obtain the cooperation of both architects and contractors. On the motion of Mr. Archibald, seconded by Mr. A. Beaugrand-Champagne, the report was adopted, after discussion by Messrs. Archibald, Doran, Vanier, Beaugrand-Champagne, Chausse, J. Venne, and Monette.

The treasurer's report showed receipts of $7,181, including a balance of $4,734 brought forward, and expenditure of $5,954, including a purchase of $2,977 of war bonds, the balance in hand being $1,226. In the report of the Quebec section it was stated that Mr. E. B. Staveley had been re-elected president and Mr. J. S. Bergeron re-elected secretary and treasurer. The balance in the bank is $149. A discussion on a reduction of fees, proposed by Mr. J. Perrault and seconded by Mr. W. S. Maxwell, followed. It was agreed, on the motion of Mr. Beaugrand-Champagne, seconded by Mr. J. Venne, that the fees of members remain at $15 and those of the students be reduced to $2. This was carried by 18 to 9.

The election of officers resulted as follows: President, Mr. Hugh Vannace; first vice-president, Mr. J. A. Monette; second vice-president, Mr. J. H. LeBon; secretary, Mr. J. E. Vanier; treasurer, Mr. D. M. MacVicar; members of the council: Messrs. U. J. Asselin, Alphonse Piche, A. Beaugrand-Champagne, J. M. Miller, E. I. Barott; delegates to Royal Canadian Institute of Architecture: Messrs. Alcide Chausse, D. R. Brown, J. P. Ouellet, Herbert Raine, and Joseph Perrault.

Some correspondence between Sir Robert Borden, Hon. R. Rogers, and the society, relative to plans submitted to the Department of Public Works for the erection of a building in Ottawa for the Department of Justice, was read. It was agreed to hold the next meeting of the association in Quebec.

Port Traffic on Atlantic Seaboard

The events of the past two years have directed special attention to the economic advantages of port facilities for the Dominion. The large amount of traffic which our Atlantic seaports are required to handle is shown by the export figures for the year and a half ending September 30, 1916. During that period Montreal exported goods to the value of $388,683,779; St. John came second, with $176,013,031; Halifax third, with $46,382,131; and Quebec, $6,298,356. St. John was under a heavy handicap as far as grain shipments were concerned, owing to the destruction of the Intercolonial Railway elevator, the whole burden of this particular class of traffic being thrown on the Canadian Pacific Railway. It was, however, carried out in a very successful manner.

Have Opened Toronto Office

The S. K. F. Ball Bearing Company, Ltd., have opened an office at 47 King West, Toronto, with Mr. Gordon Janes as Canadian representative. For the past four years Mr. Janes has been manager of the machinery department of the Canadian Fairbanks-Morse Company. Organization will be completed shortly. The parent factory is located at Gothenberg, Sweden; factory and offices at Luton, England; administrative office in New York City; factory and selling organization for the United States at Hartford, Conn.; factory also at Paris, France. The company manufacture the S. K. F. self-aligning ball bearings.

Mr. Michel, Consulting Engineer

Mr. B. G. Michel, A. M.Can.Soc.C.E., Member Inst. Municipal Eng. Am. and New Engl. Water Works Association, recently Engineer for the Town of Carleton Place, Ont., and the Corporation of the County of Lanark, announces that he has opened offices in the Bank of Toronto Building, Kitchener, Ont., for consulting practice in civil and sanitary engineering.

Pure Water and the Public Health

Purification Imperative if Disease-Laden Water is to be Prevented —Progress of Purification in Recent Years—The Typhoid Toll

By George A. Johnson*

WATER is something we all must have. When we discover foods which do not agree with us we cut them out of our menus—sometimes —but pure water, if its temperature be right, has no effect but for good on anyone. Impure food touches only a part of a community. Impure water reaches all. If pure food agitation is imperative—and it cannot be denied that it is—then pure water supplies are even more necessary. Impure foods oftimes bear sensible red flags of danger which warn the discriminating prospective consumer against them, but impure water may be served in the guise of cleanliness, and in its crystal, wholesome appearance be consumed with entire confidence, and still be heavily charged with the harbingers of disease and death.

Our forefathers obtained their drinking water supplies from wells and springs, as many communities do to-day. Only as a last resort did they go to the nearest stream. This was not because they thought the waters from such sources were dangerous, for they knew nothing of the typhoid germ—in fact, none of us knew anything about it thirty years ago—but for the far simpler reason that spring and well waters are usually not only clear but cool.

Water Purification the Prophylactic.

As communities grew in size such primitive water supplies as had sufficed in the past were outgrown, and the public waters, lakes, ponds, and rivers were drawn upon more and more largely. There was enough typhoid in those days, anyway—"bowel trouble" they called it then—but with more general use of contaminated public waters sharp and widespread epidemics of typhoid fever occurred, and the score of endemic typhoid was greatly enlarged. What could be more natural? Everybody knows that it is first-class hydraulics to construct drains according to the laws of least resistance. Consequently, it was, and still is, natural for communities and individual householders to lead their wastes by as direct routes as possible to the nearest waterway. As the population increased these waters received more and more pollution, but the germ theory of disease had not yet been established, and the public paid a heavy debt to convenience in water-borne disease.

Schemes for sewage purification were set on foot, developed and adopted widely, but to this day none of them has shown ability, reliably and continuously, to purify sewage so that it will not be a menace to health when discharged into public waters, and so the present generation of sanitarians rely chiefly upon water purification as the infallible prophylactic, where the widespread use, as sources of water supply, of inevitably and unpreventably polluted rivers and lakes is unavoidable.

Advent of Water Purification in America.

At the time of the Hamburg cholera epidemic, in 1892, when 17,000 cases occurred, caused by the use of foully-polluted waters, less than a half-million people in America were being supplied with filtered water. There were some small filters, but the people had not grasped the idea of filtration with avidity, and it seems to have required the Hamburg epidemic to awaken them.

During the same year that cholera was raging in Hamburg it appeared in New York harbor, and this fact spurred into action the officials at Lawrence, Mass., where a plant was quickly built for the purification of the polluted Merrimack River water. This incident really marked the opening of an era of practical accomplishments in America in the purification of municipal water supplies by filtration.

Still, the progress was slow, painfully slow. The speaker made a personal study of the water supplies of Japan some fourteen years later—in 1906, to be exact—and found that in that what some still are pleased to call "heathen country" a greater number of people were being supplied with filtered water than in the United States. That was only ten years ago.

The "Era of Light" in America.

All matters of human betterment are the result of slow transitional advancement. Old prejudices and deep-rooted beliefs established through the practice of centuries are not to be uprooted in a moment. So with water filtration. It remained for the terrible example at Hamburg to sink into the minds of the American public before a healthy movement for filtration could be expected. But it was bound to come, and it did come.

Slowly, but surely, the American people began to see that their rapid growth in population could only be followed by a corresponding increase in the pollution of the lakes and rivers of the country, from which the bulk of the public water supplies are drawn. With increasing pollution of the public water supplies must come increasing sickness and death, unless those supplies were purified before use. And so the practice of filtering the water supplies of our cities and towns began to grow rapidly, the decision to adopt filtration being hastened by the increasing death toll from that commonest of water-borne diseases, typhoid fever, and by the profitable example of other communities similarly situated who had minimized their water-borne death rate by filtration. More and more cities, convinced by the experience of others, adopted filtration.

Marked Progress.

Starting at the time of the Hamburg epidemic, less than half a million people in this country were supplied with filtered water. Eight years later, in 1900, less than two million people were being so supplied. Between 1900 and 1910, however, municipal water filtration showed a wonderful growth, and in 1910, or six years ago, nearly eleven million people in this country were receiving filtered water. At this date a careful census shows the total number of filter plants in operation in the United States to be 616. The total population of the communities supplied from these plants is about 17,500,000. The total daily filtering capacity of these 616 water filtration plants is 3,261,142,000 gallons, or enough to give each inhabitant of the United States 30 gallons of filtered water per day.

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Since 1910, therefore, the progress in municipal water filtration in America has been very marked. In the last six years the population so supplied has increased 62 per cent., and the total capacity of filter plants in operation has increased 78 per cent.

Results Accomplished.

What have been the results of such tremendous increases in the practice of water filtration in America?

Fourteen years ago 2,700,000 people in the United States were being supplied with filtered water. Now 17,500,000 people are so supplied. Fourteen years ago the typhoid fever death rate in all the registration cities of the United States, whether they had filtration or not, was 36 per 100,000 population living; now it is 14, or 61 per cent. lower. This means that in every 100,000 people the lives of 22 are saved each year. Among the 17,500,000 people now supplied with filtered water this would make a grand total of 3,850 lives saved each year.

The plain, unvarnished fact is that 20,000 people in this country still die each year of typhoid fever, and that 300,000 people suffer from it. In each decade one in every 33 people in this country has typhoid fever. Now, typhoid fever is a thoroughly preventable disease. No one need have it. It is only caused by taking into the mouth the specific germ; and, utterly distasteful as the statement is, it must be pointed out that the germs so enter the mouth only with the excrement of another human being. It is in this way that a water supply which contains the sewage of human beings causes typhoid fever among its consumers.

Water filtration costs on an average throughout the United States about 40 cents per person per year, or something less than one cent a week. These figures are sound, and the financial records of hundreds of cities bear them out. And so if a city of 20,000 people spends each year 40 cents per capita for purer water, and thus each year prevents a single death and the attendant fifteen cases of illness from typhoid fever, it will come out even financially and increase its self-respect into the bargain.

Water-borne Typhoid Fever Epidemics.

When the amount of typhoid fever in a community suddenly increases in a material degree the disease is said to be epidemic. While cities will complacently suffer a frightfully high endemic toll a sudden outbreak usually is followed by the flurries of an investigation. In outbreaks of magnitude the water supply is usually found to be at fault.

It is strange that civilized communities will allow water-borne typhoid fever epidemics to occur again and again and do nothing worth while toward preventing future outbreaks. While the city is in the grasp of the fever all kinds of nice promises are made. Maybe plans are drawn for a filter plant and submitted to the people, but several months have passed by this time, the majority of the people have forgotten the epidemic, and the bond issue is voted down. The speaker knows of one community where, on Christmas Day, a few years ago, one in every ten inhabitants was down with typhoid fever. Apparently there was no doubt in the mind of anyone that the direct cause was the contaminated water supply. The expert investigation into the causes of the epidemic showed this positively. A filtration plant was promptly recommended, but factional differences immediately sprang up respecting its location, and the project died peacefully. Within a year this same town was visited by two more typhoid epidemics, both caused by the polluted water supply, but the filter plant has not yet been built, and the inhabitants of that town are as much in danger of more epidemics as ever.

Pure Water Reduces Typhoid Fever.

The filtration of polluted public water supplies is always followed by a pronounced reduction in the typhoid fever death rate. In Northern cities, where the house fly and general unsanitary conditions are not such factors in typhoid transmission as is unfortunately still true of many Southern cities, the first effect of water filtration is much more clearly indicated. A few representative examples of this are given in the accompanying table, where the typhoid fever death rates in certain cities before and after filtering the water supplies are given:

	Average typhoid fever death rate		P.C. reduct'n in typhoid fever death rates.
	Before filtration.	After filtration.	
Albany, N.Y.	109	28	74
Charleston, S.C.	106	62	41
Cincinnati, O.	**56**	**11**	**80**
Columbus, O.	83	17	78
Harrisburg, Pa.	72	33	54
Hoboken, N.J.	18	13	28
Indianapolis, Ind.	46	28	39
Lawrence, Mass.	**110**	**23**	**79**
Louisville, Ky.	57	24	58
New Haven, Conn.	40	25	38
New Orleans, La.	**39**	**26**	**33**
Paterson, N.J.	29	9	69
Philadelphia, Pa.	63	20	68
Pittsburgh, Pa.	132	19	85
Providence, R.I.	19	13	31
Reading, Pa.	53	35	34
Scranton, Pa.	25	10	60
Springfield, Mass.	22	22	0
Washington, D.C.	55	31	43
Wilmington, Del.	35	24	31
Weighted averages ..	60	21	65

According to Hazens theorem, where one death from typhoid fever has been avoided by the use of better water a certain number of deaths—probably two or three—from other causes have been avoided. The records from fifteen representative cities ("Present Day Water Filtration Practice," Journal American Waterworks Association, Vol. I., No. 3, p. 516, 1914) bears out this assumption in a striking manner, as follows:

Death Rate from All Causes and from Typhoid Fever in Cities Before and After Filtration.

Per 100,000 population.	Before filtration.	After filtration.
Total death rate	1,870	1,730
Typhoid fever death rate	67	25

Typhoid lives saved. 42.
Other lives saved, 98.

Vital Capital Saved.

The speaker has figured ("The Typhoid Toll," Journal American Waterworks Association, Vol. III., 2 and 3, 1916, p. 310-311) that pure filtered water, or water of equal purity furnished to all of the urban population of the United States would avoid some 45,000 cases of typhoid fever and prevent 3,000 deaths from this disease each year. Assuming that at least two lives would coincidentally be saved from death from causes other than typhoid fever through the substitution of pure for impure water, and from the brief discussion of Hazens theorem and the accompanying statistics just given, it would appear that such an assumption is justified, we have a total of 9,000 lives annually which could be saved each year by providing pure water in all of our cities and towns which now have grossly or slightly impure supplies.

The 3,000 typhoid lives and the treatment of the accompanying 45,000 cases represent vital capital in the sum of $22,500,000. If we allow but $3,000 each for the 6,000 lives saved from death from other diseases, we have an additional vital capital saving of $18,000,000; and half as much more would be saved in the cost of medical treatment, wages, and depreciated vital energy.

In all, then, universal pure water supplies in the cities and towns in this country would save over what is now being saved—some $50,000,000 annually in vital capital. The cost of furnishing 110 gallons of pure filtered water per capita per day to 34,000,000 people—the urban population of the United States not supplied with filtered water—would cost, at 40 cents per capita per annum, a total of $13,600,000 annually, or a little more than one-quarter of the saving.

Of course, this comparison is neither exact nor hardly fair, since a considerable percentage of the urban population is now supplied with water so pure as not to require filtration. But the error is on the conservative side, and the figures show that at the very least, at an expenditure of one dollar for prevention in the form of pure water, the public health of the country would benefit in the proportion of four times that cost in saved vital capital.

Government Ownership and Management of Railways Severely Condemned

A SEVERE indictment of Government construction, ownership and management of railways, and the outline of a plan for the consolidation of the G. T., G. T. P., Transcontinental and C. N. R. lines—making a second transcontinental route—were the main features of a paper on "Canada's Railway Problems," read by Mr. W. F. Tye, past president, at a meeting of the Canadian Society of Civil Engineers, Montreal, on January 18. The paper was a very comprehensive one, dealing with the subject from many angles, and contained a mass of facts and figures as to construction, management, rates, etc. Mr. Tye explained that when the commission to investigate Canadian railways was apointed he wrote to Sir Henry Drayton and Mr. Smith, the chairman, offering to put at their disposal such information as he possessed, feeling that he could be of service in view of his independent position. Subsequently he visited Ottawa and afterwards consulted his friends as to writing a paper on the subject. The views he would express were his, and his alone. After careful consideration of the question he had come to the following conclusions:

1. The National Transcontinental, the G. T. P. and the C. N. R. are unable to earn their operating expenses and their fixed charges. Canada has built and is operating the first of these roads, and Canada and the various provinces have guaranteed the principal and interest of most of the bonds of the other two. As the roads are unable to earn their fixed charges, they must of necessity be paid by the country.

2. The failure of these roads is due to the duplication of lines by all the railways, encouraged and bonused by the Government; to the excessive cost of the G. T. P. and National Transcontinental railways; to the failure of the G. T. P. to provide itself with an adequate system of feeders in the West, and to the construction by the C. N. of the long and unproductive stretches of road across British Columbia and Northern Ontario without feeders, terminals, etc.

3. If the C. N., G. T. P., and National Transcontinental be maintained in separate systems, it will cost at least $400,000,000 to build the necessary branch line feeders and terminals, to provide them with adequate rolling stock, and put them in proper physical condition to compete with the Canadian Pacific.

4. It will be necessary that the G. T. P. build five to six thousand miles of feeders in the West.

5. It will be necessary that the C. N. R. build two to three thousand miles of feeders in the East and terminals costing many millions in Montreal, Ottawa, Quebec and Vancouver.

6. Canada has already sufficient railway mileage for years to come. The additional mileage necessary for these roads could only be had by duplicating existing lines. Such duplication of lines would only add to the burden to be borne by Canada in the way of subsidies, guarantees, etc., without doing the country any good.

7. Canada has sufficient railway mileage and traffic for two good transcontinental systems—the C. P. R. and another—but not enough for three.

8. A consolidation of the G. T. R., G. T. P., Transcontinental and C. N. railways would give a well balanced system. The G. T. R. has an excellent system in the East, with terminals in all the large and important centres, and the C. N. R. has not. The C. N. R. has a good system of feeders in the West, the G. T. R. has not. Each is strong where the other is weak. Combining them must of necessity be the most economical and efficient way of handling the situation.

9. Such a combination would not require more than $100,000,000 to provide it with sufficient rolling stock and to put it in proper physical condition to compete with the C. P. R.

10. The saving in capital cost would be at least $300,000,000, and at present fixed rates of interest the saving in fixed charges at least $15,000,000 per annum.

11. The Transcontinental cost $100,000 per mile to build. The parallel C. N. R. cost less than $50,000 per mile, and is in every way as efficient an instrument of transportation. The Quebec Bridge with approaches, will cost $40,000,000, and will not be necessary for many years to come.

12. The Transcontinental, including the Quebec Bridge, has cost Canada at least $100,000,000 more to build than it would have cost the C. P. R. to build as efficient a road.

13. Including operating expenses and fixed charges, it costs the C. P. R. about $70 to do $100 worth of business. Including operating expenses and interest on cost, it costs the Intercolonial and other Canadian

Government roads from $200 to $220 to do $100 worth of business.

14. Canada should follow the wise example set by Sir John Macdonald when dealing with the C. P. R. in 1879-80 and form a new private corporation with sufficient power and the necessary safeguards to take over and consolidate the G. T., G. T. P., Transcontinental, and C. P. railways, and develop another C. P. R. rather than to have the Government take them over and develop another and a vaster and more expensive Intercolonial.

15. Conditions for the formation of such a company are much more favorable than they were in 1880, as western Canada had not then been proven as it since has been to be capable of supporting a large and prosperous population.

16. Such a combination would start with gross earnings of at least $100,000,000 per annum, with a probable average increase of 8 per cent. per annum and probable net earnings of from $25,000,000 to $30,000,000 per annum and a net revenue from other sources of about $2,800,000.

17. Its fixed charges at consolidation would be about $35,000,000, and it would be under the necessity of spending in the first five to seven years at least $100,000,000 to provide rolling stock and to put its properties in good physical condition.

18. Deficits for some time to come would be inevitable, owing to the heavy fixed charges amounting to about $35,000,000, as compared with $10,300,000 per annum of the C. P. R.

19. As these high fixed charges are caused by the excessive cost of government construction, and by duplication of lines, bonuses and guarantees by the government, Canada must pay for them.

20. The fixed charges would be at least $15,000,000 less with one private system than with two, and very much less with private than with government management.

21. With such a combination as has been outlined the series of deficits should not last more than five to ten years, after which the road should be very successful.

22. In order to control its policy and to share in its certain prosperity Canada should have an interest in the new company. The Dominion Government should furnish 40 per cent. of the money required, own 40 per cent. of the stock, and appoint 40 per cent. of the directorate, but take no part in the actual management. This would give all the advantages of government control without any of the manifest disadvantages of government management.

23. Once this combination was successful, Canada should once and for all abandon the vicious policy of bonusing railway construction either by gifts of money or land, or by the still more vicious policy of guaranteeing the bonds of railway companies of which it has no direct control.

Management of the Consolidation.

Mr. Tye elaborated these points at great length, giving minute statistics in support of his contention. On the question of how such a consolidation should be managed, he remarked that it did not seem possible that anyone who had given serious thought to the matter would be in favor of government ownership of such an extensive system, more especially in a country so dominated by politics as was Canada. One could easily imagine what the result would be. Before the first election the cry would go up for lower rates, which the politicians to suit their needs would grant. This would result in deficits such as had been so common on the Intercolonial. These deficits and the fixed charges would have to be met by taxation. The C. P. R. would have to meet the government rates, which would surely result in the bankruptcy of that road or its being taken over by the government. If all the roads were nationalized the cost would be too much for the country to finance. There would be a lack of continuous management as each party as it obtained power would want to reward its own politicians by giving them the best positions on the railway and the best men would not be selected.

Mr. Tye knew of no system of government owned railways that had been really successful. Canadian experience of government managed railways had not been such as to justify such a gigantic addition to public responsibilities. Canada had five government owned railways and not one of them had earned interest on its cost, and only one (the T. & N. O.) earned its operating expenses.

Government construction and management had been extravagant and unsafe. The C. P. R. had proved a great financial success, the G. T. R. a moderate success, the C. N. R. a financial failure, the Transcontinental, the G. T. P. and Intercolonial great financial failures.

A Reversal of Policy Necessary.

He could not see how such a consolidation as he suggested could be a failure with the stock guaranteed by the government and with all the possibilities for traffic. It would be necessary, however, to spend a certain amount of money to link up the various roads, and the effect of this would be to shorten the mileage, improve the grades, give the requisite terminals and supply the necessary feeders. The great drawback of this scheme was the present duplication of lines and the excessive cost of construction, making the interest charges very high. Mr. Tye concluded by saying, "Surely it is time that Canada should stop and consider whither we are drifting and demand a sharp reversal of its railway policy that has led to such unfortunate results."

Mr. M. J. Butler, after expressing his thanks for the very valuable paper, said that he was not a believer in government railways; he had had five years' experience of them and that was enough. He had not thought of the solution suggested by Mr. Tye. The country had gone to an enormous expense in the matter of railway construction, and his idea was that we ought to secure some benefit from it, but this would not be achieved under government management. Still, it was in the power of the government to create a body, with capable officials, which would be free from politics, and which would undertake the management of the lines.

Mr. H. Vaughan declared that the railway problem would have to be faced. No one could doubt the absolutely reckless way in which construction had been carried out. He was skeptical whether such a scheme as suggested by Mr. Tye would be popular enough for any government to put it through.

In the course of further discussion Mr. M. J. Butler referred to government expenditures, and instanced the Hudson Bay Railway as a particularly bad example of waste of money on foolish schemes. There was also the Welland Canal and other public works, which he regarded in a very unfavorable light.

Retiring President of Montreal Builders' Exchange Reviews Past Year's Work

MR. J. P. ANGLIN was elected president for 1917-18 at the annual meeting of the Montreal Builders' Exchange, held on January 22. The report and balance sheet submitted by Mr. D. K. Trotter, the secretary, was read and approved, being considered satisfactory in view of the circumstances of the year. Mr. Anglin referred to the scheme for the hire, sale, and exchange of contractors' machinery, the property of members. He spoke of the utility and economy of such an exchange, and asked for the co-operation of the members.

On the motion of Mr. Anglin, seconded by W. C. Munn, a resolution was passed recognizing the urgent need of a bureau of municipal research for the City of Montreal for municipal management and accounting. The exchange was willing to co-operate with other bodies in pressing upon the attention of public-spirited citizens the desirability of such an institution, and of having it financed by private contributions and from other funds.

Mr. F. B. Locker moved, and Mr. A. Cross seconded, a resolution in favor of the exchange getting in touch with other public bodies and organizations to discuss whether it is expedient that a preferential tariff within the Empire should be enforced, so as to encourage manufacturers who may wish to do an export business with Britain and the allies and build their factories in Canada. This was agreed to.

Mr. John Quinlan, the retiring president, then gave his annual address, in the course of which he said:

"In presenting you with my report for 1916 I do so with the feeling in which, I believe, you all share—that we have passed through one of the most eventful years in the history of this exchange. The war which is now in its third year keeps steadily progressing; and, while we have reached the point when we can safely say that there is absolutely no doubt of the ultimate result, we still find it necessary, in order to bring about its speedy and satisfactory conclusion, to give the Allies the first call on our men and material. You have felt the full force of these altered circumstances, and it speaks well for your various organizations that the vast majority of them have steadily maintained and increased their standing and reputation.

"While the building permits issued by the City of Montreal would indicate an amount of building done in 1916 considerably less than that of 1915, the figures do not by any means give a correct idea of the amount of construction work handled by you in the year which has gone. As a matter of fact, if we were to take an inventory of the actual business done by each member of this exchange we would find that our operations in 1916 more nearly approached the normal than the city figures would indicate. The season started in with little or no business offering, but the demand for building increased with the advent of midsummer and autumn until we found ourselves in the position where it was not a question of how much work we could get, but how suitable labor and materials could be secured speedily enough to fill the contracts offering. Of course, the great demand was for factories and munition plants of all kinds. Most of these structures were built outside of the limits of the City of Montreal, hence the reason for their not appearing in the statistics furnished by its building department, and most of them were erected within a radius of a hundred miles by Montreal contractors, and I have the greatest pleasure in complimenting you on the speed and thoroughness with which you carried out these contracts under conditions which were far from ideal. I will, indeed, venture to say, gentlemen, that the erection of some of these plants by you created a record in speed and thoroughness which has never before been reached.

"At the moment the building contracts in sight for 1917 do not seem quite so many, but nevertheless the general public are prosperous, and we may expect to see in the near future a more general demand by our citizens to own their own houses and to occupy larger and better ones. During the last three years Montreal has grown, but the number of new houses erected in that time forms a small percentage of the total amount of building operations. There are at present few vacant houses in the city, and already a demand is growing for homes of all descriptions. We must also expect a large increase in the number of existing school buildings and a still greater number of factories.

"The period of this war has been productive of many new difficulties, but I believe that the close of the war especially will present more varied and acute problems to be solved. For one thing the amount and quality of available labor and its assimilation into the industrial life of our city and province will require careful study, and we, as builders and as citizens, must be prepared and organized to deal with these subjects in a manner satisfactory to all the interests involved. Canada has at present about 400,000 men in khaki, recruited largely from the ranks of the skilled mechanics. Every effort will, I am sure, be made by you on their return to place them in positions for which their training and experience fits them.

"Naturally the difficult conditions of the past year have been reflected in the ordinary work of the Exchange. While attendance at our meetings has not been so large and the interest of members not so great as could be wished, nevertheless an appreciable amount of work has been done, and the Exchange is being regarded more and more as an organization with a watchful eye on all matters affecting the interests of its members, and whose power to effect reforms and rectify abuses in our trades and the conditions under which they are operated is limited only by the amount of active interest you take in the work of your directors and the support you give them.

"Your Exchange has during the latter part of last year concerned itself mainly with the inauguration of an exchange for the hire and sale between our members of contractors' machinery not in use, and with pressing upon the Hon. Mr. Taschereau certain amendments to the bill which he introduced last session at Quebec and succeeded in having adopted, regarding the privileges of workmen, supply men, sub-contractors, and contractors. As soon as your directors learned that it was the intention of the Provincial Minister of Public Works to bring forward this measure they appointed a representative and influential committee to study the subject, frame, if necessary, other and more suitable amendments, and in general to take care that the interests of our members were not jeopardized. In order to obtain as wide an expression of opinion as possible your board, at the request of this committee, called a general meeting of the Exchange, when many valuable suggestions from the members present were received. Suggestions were also invited from other bodies. The bill as finally approved by the legislature improves but little the position of the workmen, the supplier of materials, and of the sub-contractor, and leaves the general contractor as he was. The work of your committee was rendered particularly difficult by the fact that this was a government measure, and the greatest pressure had to be brought to bear in order to have our amendments considered. Further, the short time that elapsed between the printing of the bill and its presentation to the House increased our difficulties, and it speaks volumes for the watchfulness and diligence of this committee that they safeguarded our interests so well. The heartiest thanks, not only of the members of this Exchange, but also of every builder and building supply man in the Province of Quebec are due its members. A copy of this bill as soon as printed will be mailed to each member. I may remark in passing that perhaps a good deal of the dissatisfaction that existed among our ranks in regard to the previous Lien Law was due in a measure to the fact that every member did not exercise his privileges, and I would strongly urge each one of you, as soon as you are acquainted with the terms of the new measure, to exercise your rights to the full. The law has not been amended to our entire satisfaction, and the only way we can convince the government that the suggestions we submitted were in the best interests of the building public and the business interests we represent, will be for each one of us to exercise, as soon as possible and necessary, our rights under it. Should we all do this, I am convinced that within six months the government will be constrained to prepare a new bill, and there will be no necessity for us to agitate in the matter at all.

"In regard to the exchange for the sale and hire of machinery, inaugurated a short time ago, arrangements are practically completed, and more enquiries for the use of equipment are being received than can be satisfied. There can be no doubt that the scheme has great possibilities for our members, especially in regard to convenience and economy, and those of you who have plants lying idle will help to make the plan a success and of benefit to yourselves and your fellow-members by having your lists of machinery available for the purpose sent in as speedily as possible.

"It is a pleasure to recall that some of our members who were noted for their skill in construction work are now engaged in pulling up and tearing down—in smashing German lines and German frightfulness. I refer specially to Brigadier-General Loomis, to Major Cape, to Assistant Deputy Quartermaster-General McRitchie, to Paymaster Murray, and to the Bonnell brothers. I am proud to call these gentlemen fellow-members, and I am sure I express your thoughts when I state that they will finish the contract they have presently on hand on schedule time, fully in accordance with the specifications, and to the entire satisfaction of their clients—the British Empire. We wish them all a happy and speedy return; and when their present job is finished, and we know from their past record how well it will be done, we shall be honored to have, as we have had before, the benefit of their co-operation, their counsel, and their riper experience."

The election of officers resulted as follows: President, Mr. J. P. Anglin; vice-president, Mr. W. C. Munn; second vice-president, Mr. Robert F. Dykes; directors: Messrs. Alex. W. Bremner, Alex. Charette, L. J. Conroy, A. Cross, T. Douglas, W. M. Irving, D. McCuaig, W. E. Potter, J. J. Roberts, J. E. Walsh, and W. E. Ramsay.

In returning thanks for his election, Mr. Anglin asked for the assistance of all members in promoting the interests of the Exchange and in fostering a get-together spirit.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Cast Concrete Pulley Replaces Broken Cast Iron One

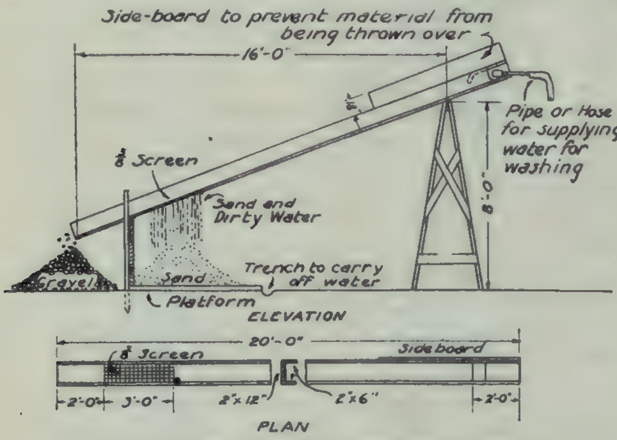
A broken cast iron pulley was recently repaired by pouring it full of concrete, according to H. S. Carpenter in Engineering Record. The pulley, which is one of a pair carrying the main elevator in a large stone-crushing plant, is 54 inches in diameter, with a 20-inch face. In the failure nearly the entire rim was broken, but an extra pulley was not available, and it took some time to secure a new one. To avoid shutting down the plant in the meantime, a form was built in place around the remains of the old pulley, using perforated metal, faced with building paper for the rim and wood for the sides. The belt was left in place, and the whole interior of the form poured full of 1:2:3 concrete. Pouring was finished at 6 p.m. on Saturday and the concrete pulley was put in service at 11 a.m. the following Monday. The job was a complete success. The belt runs directly on the concrete.

A Gravel Washing and Screening Chute for the Small Job

The careful contractor or builder does not like to use bank run gravel of doubtful grading and high dirt content. He is often led to pay a high price for screened material when he might use cheaper bank run gravel if he did not think the expense of fitting out a screening and washing plant would be too high to pay on a small job. A simple chute with a section of screen placed in the bottom near the lower end, as in the accompanying illustration, will provide a screening and washing device which is amply sufficient for the average small job, and its cost is low enough to warrant its use.

The slope of the chute must be sufficient to allow the material to roll down the incline, and is usually found to be about that shown in the illustration. The sideboard prevents the material from being thrown over, and the pile of gravel to be screened and washed should be placed near the high end of the chute, on the side opposite to the sideboard. The best results are obtained when the material is shoveled into the chute as fast as it is needed in the concrete mixer. This makes it unnecessary to shovel the screened gravel and the sand away from the bottom of the trough.

The material is washed by means of a stream of water supplied at the high end of the trough from a pipe, to which is attached the hose from the hydrant or pump. This water also assists in carrying the sand and gravel down to the screen. The sand is caught on a platform and prevented from mixing with the gravel by a wall built of boards nailed to the chute support. The dirty water runs down the platform and is carried away in a trough.


Side-board to prevent material from being thrown over
16'-0"
Pipe or Hose for supplying water for washing
⅛ Screen
Sand and Dirty Water
8'-0"
Gravel
Sand
Trench to carry off water
Platform
ELEVATION
20'-0"
⅛ Screen
Side board
2'-0"
3'-0"
2"x 12"
2"x 6"
2'-0"
PLAN

A simple trough to screen and wash bank-run gravel.

Two men can wash and screen gravel with very satisfactory results, using this device, and the material supplied for the concrete may be proportioned carefully, insuring good concrete in return for the expense of their labor.—Cement World.

Setting Reinforcing Bars in Hollow Concrete Floor Beams

Cornwall, Ont., Jan. 17, 1917.

Editor Contract Record:

I read with a good deal of interest your article on the Hospital for the Insane at Whitby. I presume the article was intended to instruct as well as interest. There is one part of it, however, that is rather indefinite. On page 32, where you describe the making of the beams, it says the collapsible steel moulds used to produce the hollows in the beams are set and properly spaced. To these cores are solidly attached the steel reinforcing bars. Now, this is where the puzzle appears, for if the steel rods are solidly attached to the cores or moulds, how do they easily remove them?

I would also like to know the area of the cross-section and the thickness of the shell.

Yours very truly,

Henry Williams.

[The method of holding the reinforcing rods to the metal cores was not made very clear in our article referred to, published in our Jan. 10 issue. The reinforcing is supported by thin stamped wires encircling the outside of the sheet metal moulds. Projecting hooks on the wires serve to carry the rods and hold them away from the core and in their proper position. Small loose wire stirrups at the top and bottom of the mould maintain a clearance of ½ in. or so between the wire loop and the core. The reinforcing is securely wired to the loops so that it is perfectly rigid and in the required position. The core and reinforcing are properly placed on a thin layer of concrete, and the shell is completed by pouring concrete around the core. After a sufficient lapse of time the moulds are withdrawn by collapsing the lower corners, so as to reduce the transverse section. The reduction of the core section separates it from the encircling loops, and on its removal the loops and stirrups are left embedded in the concrete.

With regard to the sectional area of the beams, this depends on the loading requirements. The cores are made in several sizes to suit varying conditions, and the thickness of concrete above or at the sides is proportioned to meet the load. The section to be used is determined after computing the shear, tensile, and compressive stresses in each instance. There is on this account no fixed ratio between the area of the hollow and the gross area of the beam, but the beams are designed to suit the conditions under which they are used. The stock beams, as manufactured at the plant of the Siegwart Beam Company, who control the patents, are made in standard sections, each one designed for a specific loading. At Whitby, however, where the government made its own beams, they were not standardized, but rather, as explained above, each individual case was provided for by varying the area. As the bottom of the shell serves no purpose in bearing load, it can be as thin as convenient—in this case about ¾ in., It is merely used to provide a flush surface to receive a plaster finish.—Editor.]

Municipal Report of South Vancouver, B C.

Mr. S. B. Bennett, municipal engineer of South Vancouver, B.C., has just presented a most interesting report covering roadway, waterworks and sewer operations during 1916. Considering the financial stringency the work on roadways has been confined chiefly to maintenance, but it is urged that considerable construction work should be carried out in 1917, including Fraser Avenue, from Twenty-fifth Avenue to River Road; the River Road, from Point Grey to Burnaby, and maintenance work on Main Street.

In all about nine and one-quarter miles of sewers have been laid, occupying a maximum of 520 men at one period. This work was all carried out by day labor, and the following paragraph from Mr. Bennett's report, as indicating his conviction that this system is entirely satisfactory, will be read with interest by other municipal engineers:

"The whole construction work has been executed in a thorough and workmanlike manner, at a low cost, and is beyond doubt superior to that which could have been expected by contract under the closest supervision. Considering that at the commencement of the work the majority of the laborers were unskilled in this particular class of work, it reflects great credit on the men and the foremen in charge, and is a plain proof of the ability of the municipality to handle to their advantage municipal work by day labor."

Owing to lack of funds, construction work on waterworks was reduced to a minimum. The system at the present time consists of approximately 172 miles of steel main and 36 miles of wooden main. The report states that a six-inch steel main on Kingsway, from Nanaimo to Joyce Road, has caused considerable trouble during the past year from electrolysis. The municipality charges a sprinkling tax of $1 for the summer season.

Considerable success is said to have attended the daylight saving experiment in St. John, N.B., last year.

Can. Soc. Civil Engineers Annual Meeting

Held in Montreal Tuesday and Wednesday of Last Week — Much Important Business Transacted — The Engineer Taking a More Prominent Part in the Civil and Commercial Activities of the Country

Members of the Canadian Society of Civil Engineers held their thirty-first annual meeting on January 23 and 24, at the society's building, Montreal. Mr. G. H. Duggan, the president, was in the chair.

The first day's meeting was devoted almost entirely to reports and the president's address. After the reading of the minutes and the appointment of scrutineers the report of the council was presented.

Report of Council (Extract).

Under the heading "General," the report mentions the appointment of the Committee on Society Affairs, under the chairmanship of Professor H. E. T. Haultain, University of Toronto, and the establishing of a Provincial Division in the District of Alberta. The following paragraph also appears under this heading:

"A very considerable amount of time was occupied during the year in Council meetings and by specially appointed committees in connection with the question of the employment of alien engineers by the Government. A general statement as to the position of this matter has recently been communicated to the membership. It is still under advisement and such further progress as may be made will be reported from time to time.

"A circular letter has been addressed to branches, pointing out that the interests of the profession in Canada will be served by giving attention to engineering matters of importance in the locality of the branch. The Calgary Branch rendered an important service to the city in the early portion of this year by reporting on the construction of a bridge over the Bow River, in regard to the stability of which there was contention. This report completely exonerated the City Engineer from the aspersion cast upon him by an Alderman, and the action of the Branch met with the approval of the Board of Control and the citizens generally."

The Society's Finances.

The Library Committee also presented their report, after which Mr. R. A. Ross moved the adoption of the report of the Finance Committee, which stated that the total receipts for 1916 were about $1,000 in excess of the next highest year, namely, 1912. The expenditure for 1916 corresponded very closely with that for 1912, in spite of the fact that franking privileges having been cancelled postage rates increased. One essential difference between those comparable years—1912 and 1916—was that during the latter year the arrear collections were something over twice those of 1912. On the other hand, the entrance fees in 1912 were very much larger than 1916. The moral of the above was that every effort would have to be made to increase the membership, which would assist doubly by increasing current as well as entrance fees.

The total income was $23,727, and the expenditure $20,085, leaving a balance of $3,642.

Mr. Ross pointed out arrears of $6,512 had been collected, but owing to the accumulation of the year, the amount in arrear amounted to about the same.

Mr. W. J. Francis spoke of the satisfactory nature of the finances, despite the pessimistic prophecies of Mr. Ross at the last meeting. It must not be overlooked that 678 members were at the front, from whom no revenue was obtained.

Branch Reports.

The reports of the following branches were read: Quebec, Winnipeg, Regina, Ottawa, Calgary, Vancouver, Victoria, and Toronto. These indicated that all branches had had successful years, one notable feature being the large number of members at the front. Thus Toronto has a third of its membership overseas, Regina 11, and Victoria 25.

Mr. Tye was informed that no report had been received from the British Columbia division, to which he replied that this was disappointing in view of the great things which had been expected from the formation of this division.

Mr. J. White then read the report of the Conservation Committee, which has been already published in the Contract Record. He then referred to the excellent results which were expected from the appointment of the Advisory Committee by the Federal Government.

A very long discussion followed, chiefly on the lines as to whether the committee should be continued, in view of the work of the Federal Conservation Commission. Mr. White stated that he had circularized the society's committee, asking their opinions on this point, and the replies had been of a mixed character.

Mr. White, discussing the action of the railways and other bodies in the matter of conservation and similar questions, expressed the opinion that there was too much talk and not enough actual work, although he would not care to minutely discuss the attitude of such bodies. The trouble was that there was too much divided effort. He then referred in detail to the return of the soldiers after the war, and stated that, in his view, the care of these men could not be placed on the government. The burden of taxes and pensions would be very great, and each community ought to take care of the returned men sent from the particular localities.

The Federal Advisory Council.

After speeches by Mr. R. McColl and Mr. H. V. Brayley (the latter advocating the continuance of the committee with a view to industrial research), Mr. R. A. Ross gave some details of the formation of the Federal Advisory Committee, of which he is a member. He was in favor of the Conservation Committee being continued, as it kept members in touch with conservation work. The Advisory Committee had asked the government to do certain things in the matter of expense, and the government had acquiesced in everything required. There were about thirty live subjects on the agenda of the committee, and a number of sub-committees had been appointed. A very large amount of information was available in the archives of the government, and it was the object of the committee to put this in such a shape that it would be of value to the public. The committee desired to be able to go to the government and to practically tell them that action would have to be taken in the matter of deveolping Canadian resources. For instance, he was interested in the enormous deposits of lignite in Saskatchewan. These could be briquetted and the West supplied with fuel at a lower cost than at present. Private enterprise would not take up this question, and the government should, therefore, invest money in putting in a demonstration plant. It was essential that public opinion should back up the committee, and in this way put pressure on the government to take action in such matters. The committee were endeavoring to get the government, manufacturers, bankers, etc., to help. They were sending out questionnaires to various people, the manufacturers being asked to state their problems, and the committee promised help in solving them. The manufacturers could help the committee and the committee the manufacturers, and by co-operation the country would get practical results.

Mr. Francis spoke of the useful work done by both the Conservation Commission and their own committee.

Mr. J. B. Challies was in favor of the number of the committee being reduced, and Prof. Brown suggested that a definite line of work might be given to the committee.

Mr. White, replying on the discussion, said that the proceedings were a justification of the continuation of the committee. The work of the Conservation Commission was to encourage other organizations to go ahead and carry to a conclusion the investigation of the Ottawa commission.

The President's Address.

On the resumption of the meeting in the afternoon the president delivered his address. He commenced with a historical sketch of the society, particularly in relation to the distribution of the membership, geographically considered. In 1887 the city of Montreal had 30 to 40 per cent. of the membership, the area bounded by Toronto, Ottawa, and Montreal 65 per cent.; the district Port Arthur to Montreal, 80.5 per cent., and the district west of Port Arthur only 7.4 per cent. In 1916 Montreal had decreased to 17.4 per cent., the Toronto, Ottawa, and Montreal area, 36.7 per cent., and the district Port Arthur to Montreal 65.5 per cent. The district east of Montreal had remained practically stationary, being 12.8 per cent. in 1887, and 11.9 per cent. in 1916, but the district west of Port Arthur had increased from 7.4 per cent. to 23.4 per cent. Montreal still maintained its lead in actual numbers over any other city, having 367 corporate members against 168 in Ottawa, which had the next largest number. While there had been a large increase in the number of members in the districts tributary to Montreal, there had been a much larger percentage of increase in the number of members west of Port Arthur, so situated that they could only reach Montreal at much expense and with considerable loss of time. It was to be expected that members so situated should feel strongly that they were best served as regarded their daily work by the local associations, and had little interest or sympathy in the general work of the society as it existed to-day. His impression was that this attitude had increased largely of late. Its tendency under the present organization was to still further increase, and if they were to build up a strong national society, representing the whole profession in Canada, it was a factor to which most earnest consideration must be given. In 1906 there were only two branches, while in 1915 there were ten branches, with 30 per cent. of the whole membership. In 1887 the members were 53 per cent. of the total membership; in 1916, 22.6 per cent.; associate members in 1887 were 15.4 per cent.; in 1916, 52.5 per cent., or, classing juniors with associate members, 57.8 per cent. Summarizing, the percentage of members had dropped from 53 per cent. to 22.6 per cent., while percentage of associate membership had risen from 15.4 per cent. to 52.5 per cent.

John Stoughton Dennis, the newly elected president of the Canadian Society of Civil Engineers.

The further remarks of the president were largely personal opinions on the future conduct of the society, and did not form part of the presidential address as given above. The statistics, he said, showing as they did a very healthy growth in membership and apparently a widespread interest, if taken by themselves, would seem to be cause for complacency and a feeling that all was well. They knew, however, from many complaints that most of the members were far from satisfied, and he felt that they had only made a start towards organizing their forces to advance the profession to that opinion in public estimation to which the engineer was entitled. The benefits from membership were internal and external. The first included professional standing amongst themselves, conferred by membership, the advancement of professional knowledge by the reading and discussion of papers, and the work of technical committees, conventions, and other society activities, etc. The other class was broadly covered by the proper recognition of the profession of engineer by the public, including the proper appreciation of the engineers' services on engineering questions and the further recognition by the public that the engineer, by his training and attainments, should be eminently fitted to take his place in public affairs, and that he should be sought as an advisor in questions not only of engineering, but as well on other important matters where his engineering training and standing qualified him to give sound advice on affairs not directly related to the practice of his profession.

In his view, they should strive for all these benefits, internal and external, but they could not hope to attain full success in their quest for external benefits until they had put their house thoroughly in order, and so organized the institution that they realized the internal benefits to the greatest extent possible, and he desired, therefore, to make a few suggestions as to the improvements within their immediate grasp.

It seemed important to have some arrangement by which the considerable portion of the membership far removed from headquarters could keep in touch with the work of the society and could take its share of directing that work. It was true that every member received a report of proceedings at the annual meeting, such transactions as the limited funds enabled them to print, and most of the members belonged to some local branch or division where matters of more or less general interest came up for discussion. This, however, was long-range work, in many cases divested by elapsed time of its interest, and there must be many who would be glad to take an active interest and discuss the affairs from time to time as they arose, but who did not care to give the time to put their views in correspondence.

The bulletin recommended in the report of the committee would no doubt do much to interest the member far removed from headquarters in the general affairs of the society, but it could not well supply the interest aroused by an active participation in the direction of affairs, and some plan should be devised by which there should be a special meeting of the council at least once a year—preferably twice—to discuss the more important affairs of the society. If it were not feasible to bring the whole council together, delegates could be sent from the provincial divisions where these existed, and arrangements could be made to nominate a councillor to represent a district where a division had yet been formed. The experiment of a conference was tried two years ago, with some success, but there was not adequate machinery in existence to continue the good work started, and the finances of the society had not permitted the expense of calling subsequent conferences to consider arrangements for this and other activities.

The president then referred to the question of the presentation of papers and the exchange of professional experience and thought, and said that the shortcomings in this respect had not been remedied. With their present haphazard arrangements interesting and valuable papers were often read at the branches that never reached the publication of the society. The present procedure almost consigned a paper to oblivion, because only a few would read all the transactions en bloc, when received in a large volume. A number of papers were read at local meetings which, while not admissable in the permanent transactions because not sufficiently technical, were nevertheless very interesting, and it seemed to him that these should reach in some form more members of the society than happened to hear them at the meeting at which they were read. He suggested an arrangement by which such papers could be printed in the monthly bulletin.

Substantial improvements could not be carried out on their present revenue. Expenses were increasing, and the amount returned to the branches was becoming a heavy tax, last year having amounted to $2,400. In his view, the members were getting practically all the service they could expect from the funds at the disposal of the council. The society must have more revenue to carry out various improvements, particularly in giving such publicity to the work of the society and profession, both to the members and to the community, as would assist in the general appreciation of the engineer. Possibly higher revenue would mean some reduction in the total toll, but those who could not afford to pay would still benefit by the more rapid elevation of the engineer and the general esprit de corps engendered in the profession. Mr. Duggan would not ask the students or juniors to pay increased fees, but suggested that members and associate members resident at headquarters, who had the use of the building and library and of the clerical staff in conducting their meetings, should pay larger dues, the increase for the associate members to be comparatively small and for full members to be of a very considerable amount. The general funds of the society should not, under the present difficulties, be devoted to the upkeep of the branches beyond the work which was of a general society nature, such as the publication of reports, actual clerical work of communication with headquarters, etc., leaving all local assessments by the branches or divisions to be made as each might determine for itself.

Reference had been made to the important work expected from the society in the influence it should exert outside its immediate membership. This seemed to be the real goal, because until governing bodies, corporations, financiers, and promoters could be made to realize that success or failure of an undertaking so often depended on the quality of the engineering advice it received, the value of that advice would not be properly appreciated, and when the public took the larger view to which he had referred and sought engineers' advice on other than strictly engineering questions, they would have approached that position which would bring the proper standing and emolument to the members of their profession. It was comparatively a new field for concerted action, and in consequence it did not seem practicable to lay down any definite course that would land them at the goal. It would seem to be rather a case of seizing every opportunity that offered either to the society or the individual who worked to that end.

Publicity of the proper kind was undoubtedly very important, and the action of those members of the Calgary branch and of the committee of ratepaying engineers in Montreal who gave much time and labor without compensation in a public service should do much for their cause, and was an example of unselfish work for the general good to be highly commended to those who might have similar opportunities put in their way. Quite recently the past president—Mr. Tye—had presented a paper requiring a large amount of thought and labor upon a most important problem, and Mr. Duggan was sure one of Mr. Tye's rewards would be the knowledge that he had brought the whole profession prominently before the public. It was not to be thought that the speaker was insensible to the public recognition already accorded to members of their profession. They were proud at the last annual meeting to congratulate three of their members who had been honored by knighthood for distinguished engineering and public services, and they knew that other members were on important public commissions.

The report of the council and a progress report by the committee on the society's affairs were discussed together for the sake of convenience. Prof. Haultain, the chairman of the latter committee, explained that it had been appointed for the purpose of recommending means to increase the prestige of the society. Since the report was issued two other points had been discussed—the vigorous enforcement of the society's by-law referring to the expulsion of unworthy members and approval of the council's stand to the effect that Canadian engineers should be exclusively employed on government work.

Report of Committee on Society's Affairs (Extract).

Your Committee has endeavored systematically to obtain the views of the whole membership regarding the various points on which the Committee is to report. The Council of the Society of its own accord also issued a circular to the whole membership earnestly inviting general co-operation with the Committee.

The work of the Committee has been prosecuted vigorously and a second general meeting of the Committee was held in Montreal on the 17th and 18th of November, when the whole field was carefully reviewed. As a result of the deliberations of this meeting we have the honor to transmit herewith the recommendations which have been so far reached. The recommendations are as follows:—

1st.—The inclusion in the List of Members of a geographical distribution by districts.

2nd.—The creation of a new classification in membership to be known as "Retired Members," in which the annual fee will be nominal, for those members over sixty-five years of age who have been Corporate Members of the Society for over twenty years, and who desire to be so classified.

3rd.—The publication of a journal or periodical at least once a month, devoted largely or entirely to the interests of the Society and its members.

4th.—The elimination of interest charges on annual dues for the first six months of the current year, a fixed charge of 50 cents being made for each period of six months thereafter during which the fees remain unpaid.

5th.—Systematic publicity in the public press.

6th.—A systematic effort to have recognized university engineering professors identified with the Society and to secure the co-operation of such universities.

7th.—The engagement as soon as practicable of a Secretary who will devote his whole time to the Society.

8th.—The election of the Nominating Committee and of the Councilors by the Districts.

9th.—The encouragement of the general use of the Society's Standard Specifications by the membership and by municipalities.

10th —The change of name from Canadian Society of

Civil Engineers to "The Canadian Institution of Civil Engineers,"

11th.—The re-drafting of the entire by-laws.

12th.—The systematic collection and filing in the library of important engineering reports in Canada, Great Britain, France and the United States.

13th.—The appointment of a Committee to be known as, say, "The Public Service Committee," whose duty it shall be to take cognizance of and report upon any or all public questions or legislation which may appear to be contrary to sound engineering practice or to the interests of our membership.

14th.—The obtaining of annual grants from the Dominion and Provincial Governments.

On behalf of the Committee we would express the hope that these suggestions which have been reached after very full and complete discussion may receive the careful consideration of the membership. The Committee has found diversity of opinion on several important points. Some of the more important features of the situation call for further deliberation before the final opinion of the Committee can be expressed.

Other questions have been under consideration, but the deliberations of the Committee have not yet progressed sufficiently to enable definite recommendations to be made regarding them. Several sub-committees are still at work and it is hoped that much useful information may be the result of their deliberations.

Submitted on behalf of the Committee on Society Affairs.

H. E. T. Haultain,
Chairman.

E. W. Oliver,
Secretary.

Mr. J. White then brought forward the case of Mr. Thomas Adams, town planning advisor to the Conservation Commission, who had applied for admission to membership, and whose application was later withdrawn. A voluminous correspondence bearing on this subject was read, and Mr. White concluded by some particularly pungent criticism of the council and management of the society. He foreshadowed an attempt to form a league to enforce certain alterations, designed, he said, to secure greater efficiency.

Name of Society Referred Back.

All the recommendations of the Committee on Society's Affairs were adopted, with the exception of the one changing the name of the society, on which, Mr. Haultain stated, members of the committee were divided. This recommendation was referred back, the committee to take a paper ballot of the members and to present arguments for and against the proposed change.

In the discussion diversity of opinion was expressed as to the name. Prof. Haultain favored a change with a view of embracing all branches of the engineering profession. The mining engineers, as an example, were not well represented in the society, and the question was whether it would not be well to eliminate the word "civil" in order to secure their adhesion.

Mr. Ross spoke of the danger of splitting up engineers into various little societies.

Mr. Francis enquired whether, if they altered the name of the society, would outside engineers join the society.

Mr. A. Dion was of opinion that the retention of the word "civil" was largely a matter of sentiment, and this should not stand in the way of enlarging the scope of the society.

Mr. G. A. Mountain pointed out that the adoption of the word "civil" was actuated by a desire to follow the name of the English society. The Mining Institute included gentlemen who could not, owing to want of engineering qualification, become members of the Canadian Society of Civil Engineers.

Prof. Haultain did not pretend that the Mining Institute was a professional body, but there was a small group of members who were anxious to make it one.

Mr. Oliver stated that the committee discussed the question of the name at great length, and were not all agreed. If the society dropped the word "civil" they might open the door to stationary and other engineers, and in this way go outside their legitimate object.

Referring to clause 13, Lieut.-Col. J. S. Dennis alluded to the excellent work of the society in discussing public questions. He particularly referred to the paper by Mr. Tye on "Canadian Railway Problems" one of the finest contributions on the subject he knew of. Such a paper and another he had seen would strengthen the position of the society, as they dealt with problems of great importance, and would encourage members to tackle such questions.

In the evening an informal dinner was held at the University Club, which was followed by a smoking concert at the society's rooms. The arrangements for the entertainment were in charge of Messrs. J. Duchastel, J. de G. Beaubien, W. D. Black, J. A. DeCew, E. S. Mattice, D. C. Tennant, and R. M. Wilson.

On Wednesday morning, by the courtesy of the Montreal Tramways Company, members were conveyed to the munitions plants of the Dominion Bridge Company, the Montreal Ammunition Company, and the Dominion Copper Products Company, later being entertained at luncheon at the Windsor Hotel by these companies.

At the afternoon session Mr. G. C. Parker, of the Ontario Highways Department, introduced the report of the Roads and Pavements Committee, a summary of which has appeared in these columns. With regard to pavements, it was, he said, proposed to get further data as to the whole pavements of the Dominion. The appendices 1 and 3, dealing with roads and pavements and with asphaltic road oils, he asked should be received, and appendix 2, on pavements, received and recommended for adoption. The committee were waiting for more information on concrete sand. The specifications as set forth in 3-1 were used in the United States and in portions of Canada for concrete pavements.

Mr. J. A. Jamieson was of opinion it would be a mistake to adopt an ironclad specification for concrete sand throughout the Dominion, in view of the great varieties of sand. Specifications should be made broad enough to cover the sand in every part of the country.

Mr. Parker said that this was the object in view. The specifications were meant to be taken as a basis, and specifications for sand to be drawn up according to the materials which could be purchased at a reasonable cost in the different localities.

Prof. Brown pointed out that these specifications were for concrete to be used in roads and pavements only.

After further discussion the reports were accepted as suggested by Mr. Parker.

The report of the Committee on Steel Bridge Specifications, brought up by Mr. P. B. Motley, elicited considerable debate.

Report of the Committee on Steel Bridge Specifications.

This Committee has had twenty meetings during the year, which have been attended by most of the Montreal members, the others having participated by letter, and a draft specification has been made and sent out to the Branches for discussion.

It is recommended that the discussion of this draft be continued during the coming year, so that the views of all interested authorities may be obtained, with a view to having the specification take such form as to make it possible for provincial, municipal and other bodies to adopt it. In the meantime it is proposed that the Committee continue its work, including the preparation of a specification for Moveable Bridges and the revision, where necessary, of the present Railway Bridge Specification.

In addition to the foregoing, it is respectfully suggested that the Committee automatically go out of office every two years and that its personnel be chosen as follows: One representative from each of the Branches and four members residing at or near headquarters. This arrangement would have the effect of providing, at all times, a working Committee, which would prepare details for discussion by the Committee as a whole.

While Moveable Bridges have not been included in the preliminary drafts of the Highway Bridge Specification and were not included in the Railway Bridge Specifications that have been issued, the Committee has given some consideration to this feature, as it is felt to be necessary for complete specifications. The Committee feels that a Mechanical and an Electrical Engineer conversant with moveable bridge practice would be of great service in this connection, and suggests that the new Committee be empowered to add to its number or to consult such experts as may be necessary to draft a complete specification.

Mr. Motley having referred to the extensive character of the work, Mr. Mountain alluded to the variety of specifications for railway bridges in use, while on highway bridges there was only the Dominion Government specifications. When the composition of the committee was considered they ought to have the best specifications in Canada. Mr. Mountain further stated that the provinces were likely to draw up different specifications. If the society would draw up definite specifications he would recommend their adoption by the Railway Board.

Several members pointed out the importance of securing the views of the branches, and it was decided to adopt the report, with an understanding that the draft specifications be sent to the branches with a request for criticism. The committee will be continued, with power to add to its numbers, the idea being to add representatives from the branches.

Sewage Disposal and Sanitation.

Mr. A. Surveyer presented the report of the Committee on Sewage Disposal and Sanitation. A deputation had asked that certain amendments be made in the Quebec laws, and also that engineers be more strongly represented on the Quebec Superior Board of Health. Only one recommendation had been carried out, while the board was still mainly composed of doctors. It was asked that the society's council appoint a committee on legislation to take up sanitary questions. This was agreed to.

A progress report on reinforced concrete was read by Mr. Francis, who stated that much work had been done, but nothing tangible accomplished. The Toronto branch had sent in an exhaustive report, and other suggestions had been received. The committee were not entirely satisfied with the specifications, and modifications were being considered.

In reply to a criticism that the committee should not wait for the American society to move, Prof. Brown pointed out that the Canadian society's reinforced concrete specifications were the only ones on the continent. The American society had followed the lead of Canada, but had not put their specifications in a definite form. The committee were desirous of ascertaining if there were any weak spots in the specifications.

The report was adopted and the committee continued.

On the report of general clauses being called for, it was stated that the chairman—Mr. H. Holgate—was in Jamaica, but that a considerable amount of work had been done. Mr. Ambrose and Mr. Oliver (Toronto) voiced dissatisfaction with the absence of the report, and an amendment to the adoption of the report in favor of changing the personnel of the committee was carried.

A progress report on steam boiler specifications stated that a Toronto sub-committee had in hand the comparison of the different Canadian codes with that of the A. S. M. E., with a view of drawing up a new code.

At the suggestion of Mr. Jamieson the council are to be asked to appoint a committee on Portland cement. He stated that he desired an enquiry as to whether the present specifications were not handicapping cement manufacturers in producing the best forms of cement.

The reports of the Electro-Technical Commission and the Committee on Educational Requirements were approved.

Mr. Butler, referring too an incident on the previous day, protested against the proceedings of council being divulged, and moved a resolution that this should not be done without the consent of council.

Mr. Tye and Lieut.-Col. Dennis supported this, and the motion was carried.

The secretary—Prof. McLeod—read a letter from the Advisory Research Council stating that confidential questionnaires were being sent out to universities, colleges, governments (federal and provincial), manufacturers, and Canadian industries, members of technical societies, etc. The letter asked for the co-operation of the society in obtaining complete information as to Canadian resources, etc.

Opportunity for Canadian Engineers.

Mr. Ross declared that the appointment of the council presented a great opportunity for Canadian engineers. The advisory council were desirous of obtaining particulars of the sources of raw materials, the difficulties of the manufacturers, and information along those lines. The society had an organization which extended to every town of any size in Canada and many outside districts. The advisory council intended to send out questionnaires to the members of the Manufacturers' Association, Society of Chemical Industries, Mining Institute, and perhaps other groups. He suggested that a joint committee of the various societies should be adopted so as to work together.

Lieut.-Col. Dennis strongly supported co-operation by the society. There was, he said, a report by a sub-committee of the society, addressed to the Prime Minister, on the national industries of Canada. This was the work of Sir Charles Ross and Messrs. Ross, Francis, McLeod, and Safford, and the members were to be congratulated that they had within their ranks men who had dealt with this question in such a satisfactory manner. He referred to the work of the C.P.R. in this connection, stating that they were engaged in a national survey of Canadian resources through 7,000 or 8,000 correspondents. The results would be remarkable, but they would show that Canada was falling far short of attempting to solve the great problems which would have to be faced after the war, unless there was a very considerable industrial development. He moved that the council co-operate with the Advisory Research Council, and that the society circulate the report on natural resources drawn up by the society's sub-committee. In the near future he would be engaged in dealing with the question of labor, and also, in the United States, with the securing of money for developing Canada. He hoped their society would make it perfectly clear that they were anxious to give the government every assistance in solving our problems, which could only be done by co-ordination of effort.

Mr. Tye seconded the motion, and said that the society was in a great measure responsible for the appointment of the research council. Three of their members—Messrs. Ross, Surveyer, and Challies—were on that council.

The motion was carried.

A telegram from the Mayor of Calgary was read, inviting the society to hold the next annual meeting in that city. Lieut.-Col. Dennis and Mr. A. S. Dawson, chairman of the Calgary branch, strongly urged acceptance of the invitation, on the ground that it was desirable to get in closer touch with the Western members, and that some important engineering works could be visited. It was decided to refer the matter to the council, with a recommendation that the invitation be accepted.

Election of Officers.

The election of officers resulted as follows: President, Lieut.-Col. J. S. Dennis (acclamation); vice-presidents, Mr. J. M. R. Fairbairn and Col. C. N. Monsarrat; members of council: District No. 1, Messrs. R. A. Ross and J. C. Smith; 2, Mr. H. Longley; 3, Mr. A. R. Decary; 4, Mr. J. White; 5, Mr. G. A. McCarthy; 6, Mr. W. Pearce; and 7, Mr. J. H. Kennedy.

On taking the chair, Lieut.-Col Dennis expressed his sincere thanks for his election. After speaking of his experience —44 years—in the West, he promised to give his best efforts so that at the end of the year it might be said something had been accomplished by their joint endeavors for the benefit of the society. He hoped that the society, with its Canadian sentiment, and having in the ranks outstanding men of the engineering profession, would do all that was possible to solve our problems. The people of Canada had not appreciated the pioneer work which had been done by the surveyors and engineers of Canada in bringing the country to its present conditions; this was particularly so as regards the West. The society were proud of the part their members were taking overseas, and he suggested that a honor roll be drawn up and placed in the society's building.

The members decided to instruct the council to carry out this suggestion.

On the motion of Mr. Francis, a cable of greeting was instructed to be sent to Col. Mitchell and, through him, to all the members at the front.

It was announced that the Gzowski medal had been awarded to Messrs. H. Holgate, Julian Smith, and R. M. Wilson for their paper on the Cedars Rapids manufacturing development.

The following gentlemen acted as a reception and introduction committee during the meeting: Messrs. William McNab, H. V. Brayley, J. A. Burnett, C. R. Coutlee, and G. A. McCarthy.

Mainly Constructional

East and West—From Coast to Coast

The Marsh, Bourne, Powers Contracting Company, Ltd., has been incorporated, with a capital of $45,000; head office at New Westminster, B.C.

The new factory of the Orillia Worsted Comopany, at Orillia, Ont., has been completed, and operations are to start shortly. The building is three storeys high, 144 x 76 ft.

The Township of North Monaghan, Ont., proposes to construct one mile of stone road this year, provided assistance can be secured from the Provincial Government on the basis of the county scheme for road building.

Negotiations will shortly be started with a view of reopening the plant of the Superior Portland Cement Company, in Orangeville, Ont. The plant has now been idle for about three years, the company having been liquidated.

At a meeting recently held in the Labor Temple, Toronto, the cement workers of Ontario formed a provincial organization. They will apply to the Operative Plasterers and Cement Finishers' International Association for a charter.

According to report, the new central span of the Quebec bridge will be ready in September next. The same method of construction is being followed as before, but special care is being taken that no weak or defective member enter into it.

The plans of the officials of Ford City, Ont., for a sanitary sewerage system for the town have been approved by the Essex Border Utilities Commission. It is proposed to temporarily employ a screening process at the river bank for the disposal of the sewage.

A petition was recently presented to the Electric Light and Water Commission of Kincardine, Ont., by a deputation consisting of the Board of Trade and the manufacturers of the town, urging that the present source of water supply be changed on account of its hardness.

Arbitrators for fixing the water rates for the City of Outremont, P.Q., have been selected. Mr. Walter Francis will represent the Montreal Water and Power Company, Mr. Arthur Surveyer the City of Outremont, while the third arbitrator is Mr. Eugene Lafleur, K.C.

The Swenson Engineering Corporation, whose head office is in Seattle, Wash., has been registered in British Columbia as an extra-provincial company, and will carry on business in that province, with head office in the city of Vancouver. The capital of the company is $50,000.

As it has been found impossible for the Dominion Good Roads Association to hold its annual convention in Winnipeg, as originally planned, arrangements are in progress for the convention to be held in Ottawa. A paper ballot of the executive is to be taken with a view of making definite arrangements.

It is reported that valuable gold deposits have been found on the Taxis River, in New Brunswick, not far from silver and lead and tungsten deposits which have lately been uncovered in York County. The discovery of these valuable ores serves to emphasize the value of the mineral wealth of the province.

The Provincial Government of Manitoba have under consideration a project for increasing the capacity of the hospital for the insane at Brandon, Man. The proposal is to enlarge the Brandon asylum so as to house the patients now at Selkirk and to use the Selkirk building as a school for the feeble-minded.

It is reported that the Provincial Government proposes to erect a 500-bed hospital on the asylum grounds at London, Ont., for the care of wounded soldiers. The hospital will be operated under the Dominion Hospitals Commission, and when the war is over the building will be turned over to the asylum authorities to use for the care of the insane.

Toronto's new incinerator is now about to be put in operation. It is built at the Don River, with its ash-run on the level of the stream and its charging-floor 10 or 15 feet higher. Its tipping-floor is approached by bridges from Wilton Avenue and Mountstephen Street. Twelve electric furnaces have been installed, and the chimney of the incinerator is 175 feet high.

The total number of building permits issued in Stratford, Ont., during 1916 was 290, as against 275 in 1915. The value in 1916 was $190,619, as compared with $209,800 for the previous year. There were 81 new residences erected during the year. They were mostly of the storey-and-a-half type, for workingmen, and were valued at $124,500. Factory additions accounted for $31,244.

A considerable quantity of ore has been taken out of the copper mine at Dorchester, N.B., and the outlook for a successful operation of the mines is considered very bright. The ore will probably be shipped to the United States to be refined, as there is no refining plant in the vicinity. Development work is also being carried on at the copper mines near Bellisle Station, King's County. The ore is of good quality.

Norcross Brothers, Montreal, have been awarded the contracts for the temporary station of the C.N.R., Montreal, in connection with the Mount Royal Tunnel, and for the excavation in connection with the same building, which is to be of steel and concrete. The more extensive contract for the excavation of the site for the main and permanent station has been let to Mr. Angus Sinclair, formerly of New Brunswick.

The Jordan Memorial Sanatorium at River Glade, N.B., a gift to the province of Mrs. James C. Jordan, of Boston, has been further improved by recent contributions from the same lady. By the erection of a dam 700 ft. long an artificial lake has been provided, which adds greatly to the value and beauty of the property. The provincial government has added improvements to the building and equipment, at a cost of over $40,000.

Negotiations are under way by a syndicate interested in building both steel and wooden ships for Norwegian interests to acquire the site of the present shipyard at Port Coquitlam, B.C., which has been established at the confluence of the Pitt and the Fraser Rivers for the erection of wooden ships. It is said that the site is the best on the Pacific Coast for steel shipbuilding, the soil furnishing ideal foundations without the necessity of building up pile and cement foundations.

The Department of Water and Sewerage of St. John, N.B., have been carrying on excavation work at the Marsh Bridge, preparatory to installing a branch outlet to the main sewer, which empties into the creek. It is desired to make an examination of a section of the main sewer near the bridge, which is blocked. When the work is completed two outlets will carry off the waste. New floodgates will be installed. They will be of wood, encased in iron, and will be ready for use in a month.

It is understood that a start is to be made next summer in connection with work on the proposed provincial highway from Windsor to the Quebec boundary. No construction which will involve any large capital expenditure is to be undertaken until after the war, but an effort will be made to bring the road into better shape by placing superintendents and repair gangs at work on various sections. The plans in hand involve a good deal of ditching, some reconstruction of small bridges and culverts, and possibly construction of short sections.

Canadian Aeroplanes, Limited, have purchased a site, 9½ acres in extent, in the city of Toronto, where they will erect an aeroplane factory, at a cost of some $200,000. The location is on the vacant property west of Dufferin Street and north of Lappin Avenue. The buildings will be of brick and steel construction, and will occupy 4½ acres, leaving the remainder of the site for future extensions. Erection is to start in the beginning of February, the plans being prepared by Mr. John M. Lyle. It is expected that the factory will be in operation early in the summer.

At a recent meeting of the York Township Council a report was submitted by Engineer Barber regarding the proposed waterworks system for the township. The members then decided to call tenders for sections "A" and "B" of the system, for which plans have been drawn up. The estimated cost of this part of the work is $320,000, and the system covers the district north of the city as far west as Dufferin Street and the Swansea and Baby Point districts. A two-foot main will be laid on Eglinton, from the city limits west to Dufferin, with twelve-inch mains on Spadina Road, Vaughan Road, Wychwood Avenue, and Oakwood Avenue. Six-inch service mains will be laid on the cross streets.

A disastrous fire at Lyall, Man., recently destroyed the large cut-stone plant owned by the Wallace Sandstone Quarries, Ltd., which was the largest plant of this kind in Canada. The loss is estimated at a quarter of a million dollars, and about one hundred men will be thrown out of employment. It is expected that it will be rebuilt in the near future. The Wallace Sandstone Quarries, Ltd., operates in Montreal, Ottawa, and Wallace, N.S., and is owned by the Peter Lyall & Sons Construction Company, of Montreal. The fire occurred at a very unfortunate time, as the company was working on the Manitoba Parliament Buildings, and there was also a prospect of stone being cut at their quarries for Ottawa.

The $1,000,000 pulp and paper mill to be erected at Port Arthur, Ont., by the Port Arthur Pulp and Paper Company, Ltd., will include the following buildings: Digester building, 26 x 209 ft.; work room, 70 x 160 ft.; pit room, 42 x 200 ft.; bleaching rooms, 26 x 200 ft.; settling tanks, 42 x 138 ft.; acid room, 36 x 108 ft.; boiler room, 110 x 100 ft.; beater room, 80 x 165 ft.; paper machine room, 72 x 230 ft.; finishing room, 90 x 170 ft.; shipping room, 55 x 170 ft. All buildings will be of brick and reinforced concrete construction, with steel trusses. No general contract for the entire work will be let, but contracts will be awarded for each building separately, and, as far as possible, are to be given to contractors in Port Arthur and Fort William. Blasting operations to clear and level the site are now in progress. The first unit will be a 50-ton sulphite plant. Operating power will be supplied by the Ontario Hydro-Electric Commission, and no transformers or generators will be needed. The Manitomac Engineering Company, Manitomac, Wis., have the contract for supplying two digesters, 16 x 52. One million hard-burned brick will be required.

Personal

At the initial meeting of the Kincardine Electric Light and Water Commission Mr. J. B. Watson was re-elected chairman.

Obituary

Mr. Frank Gilbert, at one time a member of the firm of Gilbert Brothers, engineers and contractors, Montreal, died at Westmount on Jan. 23, aged 70. The firm did considerable work in the development of the Montreal harbor.

Mr. Samuel Archer, one of the survivors of the Royal Engineers who laid out the city of Vancouver, B.C., died recently, having reached a ripe old age. The late Mr. Archer came from England in the year 1859, when he was about twenty years old, and made his home in British Columbia. After the Engineers were discharged in 1863 he went to the Cariboo country, but returned to the Coast a few years later, and had since lived mostly in Vancouver and the surrounding district.

Trade Publication

Inter Communicating Telephone Systems—bulletin No. 1017, by Stromberg-Carlson Telephone Manufacturing Company, Toronto, describing and illustrating the various types of inter-communicating telephone systems supplied by this company.

> **"The people of Canada should practice economy, which results in greater national saving. Every man over twenty-one understands how to economize, and every man can carry it out if he wants to carry it out. Let us economize. Let us make our savings serve the purposes of war. Let the people of the Dominion, by thrift and economy, make their dollars fight the Hun."—Sir Thos. White.**

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Cayuga, Ont.
Work will start in the spring on an extension to waterworks to cost $7,500. The following material is required for the project:—1 plunger pump, 500 gallons per minute; 1 steel tower stand pipe, 60 ft. high, 20,000 gallons capacity; 2,400 ft. cast iron and steel pipe, 4 in., 6 in. and 8 in. diameter; 7 hydrants; 7 valves. Engineers, Jackson & Lee, Temple Bldg., Brantford, Ont.

Edmonton, Alta.
The City Council contemplates installing a chlorine control apparatus for the bacterial purification of the city water.

Jasper Park, Alta.
Work is in progress on the road from Jasper to Mount Cavel, under supervision of Engineer Alfred Driscoll, and will be completed about July, 1917. Several bridges are required.

London, Ont.
Tenders will be called about February 15th by the City Council for the supply of cement and vitrified sewer pipes. Engineer, H. A. Brazier.

Montreal South, Que.
By-law will be submitted about February 3rd for the construction of a waterworks to cost $180,000. Engineer, E. Drinkwater, St. Lambert.

Rockland, Ont.
A supply from springs about 1½ miles from town is under consideration by the Town Council. Clerk, Jas. N. Lagrois.

St. Clements, Man.
Tenders will be received by the secretary-treasurer of the Rural Municipal Council until Feb. 1st for 3,000 yards of gravel for road construction. Clerk, Thos. Munn.

York Township, Ont.
The Township Council have instructed their engineer, Frank Barber, 57 Adelaide Street East, Toronto, to call for tenders for work in connection with proposed waterworks system for the township. Followng are the estimates:— Section A, 24-in. trunk main on Eglinton, $73,683; 16-in. trunk main on Eglinton, $27,017; 2-in. main on Spadina Road, $22,410; 12-in. main on Oakwood, $26,740; 12-in. main on Vaughan, $26,896; 12-in. main on Roach, etc., $18,085. Sec. B, 12-in. main on Jane, $13,841; 12-in. main on St. Clair, $9,102; 12-in. main on Dundas, $21,115; 12-in. main on Bloor, $6,970.

The York Township Council are receiving tenders for the following supplies until February 12th:—Cast iron pipe, special castings, valves, hydrants, tops, covers, plugs, Venturi meters, recorders, and check valves.

Railroads, Bridges and Wharves

Calgary, Alta.
F. N. Alexandria, C. P. R. Station, has been appointed architect for the addition to be made to the Canadian Pacific Railway's stockyards to cost $75,000. President, J. M. Cameron. Date of calling tenders not yet decided.

Edmonton, Alta.
The Edmonton Power Company, Ltd., C.P.R. Block, are now making surveys for an 80-mile railway from the city to site of power plant. Railway will be steam and later converted into electric. Work on power plant will be started on completion of railway in about a year. Construction camp now being arranged. Manager and engineer, E. W. Bowness.

Etobicoke Township, Ont.
Plans are being prepared for a bridge of steel construction to be erected by the Toronto-Hamilton Highway Commission, 49 Wellington E., Toronto. Cost, $16,000.

Humberstone Township, Ont.
The T. H. & B. Railway, Hamilton, Ont., are considering the construction of a railway from Welland to Port Colborne. Further details later.

Montreal, Que.
Work will be started shortly by the general contractors, Norcross Bros., 10 Cathcart Street, on the Canadian Northern Railway station to cost $150,000. They will receive tenders on roofing, electrical work, heating, plumbing, plastering, painting, excavating and structural concrete and purchase 100 tons reinforcing steel, also tiles and paving blocks.

Napanee, Ont.
Plans have been drawn for a station of brick construction to be erected by the Canadian Northern Railway, Head Office King & Toronto Streets, Toronto, Ont.

Peace River, Alta.
The Edmonton, Dunvegan & B. C. Railway have started work on the $1,000,000 steel bridge to cross the Peace River. The agitation is strong to have bridge suitable for ordinary traffic as well as railroad traffic. Engineer, N. R. Smith, Chairman E. D. & B. C. Ry., Edmonton, Alta.

St. Clements, Man.
Tenders will be received until Feb. 1st for the building of a pile bridge over Cook's Creek. Clerk of Rural Municipal Council, Thomas Munn. Plans and specifications at Municipal Office, Selkirk, Man., or Highway Commissioner's Office. Parliament Buildings, Winnipeg.

Toronto, Ont.
A bill will be submitted to the Legislature to empower the Board of Control to establish coal docks and storage, at a total cost of $2,000,000. Secretary, Thos. McQueen, City Hall.

Victoria, B.C.
The Department of Marine, Ottawa, will erect a large concrete lighthouse here as soon as the Ogden Point Breakwater is finished.

Wainfleet Township, Ont.
The T. H. & B. Railway, Hamilton, Ont., propose to construct a line from Port Colborne to Maitland. Further details when available.

Winnipeg, Man.
The Kenora & English Ry. Co. has applied for authority to construct and operate a railway line between Imperior Jct. and Winnipeg. Incorporation empowers company to develop electric or other energy and construct wharves, hotels, etc.

CONTRACTS AWARDED

East Angus, Que.
Wilfred Poulin, Marieville, Que., has been awarded the general contract for the erection of a steel bridge across the St. Francis River to cost $45,000. Work will start immediately. Steel work will probably be sub-let.

Public Buildings, Churches and Schools

Alliance, Alta.
A. M. Jeffers, McLeod Bldg., Edmonton, has been appointed architect for the school to be erected here. Secretary-Treasurer, J. A. MacTavish. Tenders will be called in the spring.

Burlington Beach, Ont.
A. Burke, 17 Mulberry Street, Hamilton, intends to erect a number of pavilions, booths, etc. Further details later.

Chicoutimi, Que.
The Hotel Dieu St. Valier are considering the erection of a four-storey addition to monastry.

Claremont, Ont.
Tenders close February 8th for masonry and carpentry work for two-room addition to school for School Section No. 15, Pickering Township; cost $10,000. Secretary, T. M. Evans.

Empress, Alta.
A. M. Jeffers, McLeod Bldg., Edmonton, has been appointed architect for 2-storey, brick construction school to be erected in the spring.

Halifax, N.S.
The Board of School Commissioners are having plans prepared by H. E. Gates, Hollis Street, for the erection of the St. Patricks Boys School to cost $100,000, on Brunswick Ave. Chairman, H. E. Pike.

The Roman Catholic Episcopal Corporation, Dresden Row, are considering the erection of a chapel. Tenders will likely be called shortly. Secretary-Treasurer, J. W. Regan, Hollis Street.

Korah, Ont.
Tenders will be received by the architect, Thos. R. Wilks, Farewell Building, Queen Street, Sault Ste. Marie, Ont., until noon, February 3rd, for the erection

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Alphabetical Index of Advertisers
Page 16

Vol. 31 February 7, 1917 No. 6

Principal Contents

Page
Editorial . . . 111
General Specifications for Concrete Highway Bridges in Ontario . . . 113
Reinforced Gypsum for Roof Decks a New Development . . . 115
Engineering and Civic Progress . . . 116
The Engineers' Club of Toronto . . . 117
Conference on Road Construction for County Road Superintendents and Engineers . . . 118
Heat Transmission Through Window Sash . . . 119
The Necessity for Adequate Methods of Waterproofing in Road Construction . . . 121
Stop-log Versus Steel Gates for a Montreal Contract 123
Present Practice and Regulations Pertaining to Pavement Openings . . . 123
Timber in Pier and Wharf Construction . . . 124
Sources of Trouble in Brick Pavements . . . 126
Present Status of Physical Tests for Granite Blocks . . 129
Practical Hints for the Contractor . . . 130
Mainly Constructional . . . 131

Canada's Problem One of Conservation and Development

IN his annual report to the Commission of Conservation, meeting at Ottawa, Mr. Thomas Adams, the town planning adviser to the Commission, discussed some of the most important problems confronting the people of the Dominion at the present time, which must be solved if this country is ever to forestall developments in a haphazard and unscientific manner. Canada's position is the antithesis of that of Europe. Her problems involve an opposite need, for, as Mr. Adams says, "Whereas the task of Europe after the war will be to restore and re-construct, the task of Canada will be to conserve and develop. We are at the opening of a new era of social construction and natural expansion and the question is not whether we will grow, but how we will grow."

There are perhaps four urgent needs, in Mr. Adams' opinion, on which emphasis should be placed: the realization of efficiency, convenience, health and amenity, by proper planning and development of land; the stimulation of scientific training and improvement in educational methods, particularly in rural districts; the improvement of the government organization, especially of that dealing with municipal affairs; the provision of facilities for social intercourse and co-operation, rural credit, and the development of industry in the rural districts. Important as all these matters are, the first requires, perhaps, the most urgent solution.

* * *

Town planning is conceded to be the most important matter exercising the municipal mind. The term does not involve the limited conception apt to be associted with it, of laying out cities with broad streets, beautiful lawns, or spacious parks. Town planning includes all this, but these ideas can, as a rule, be advocated only for the newer sections or suburbs of our cities. Town planning must equally apply to the old portions. It must embrace in its work the slum as well as the more select parts. In its broadest meaning, then, town planning is an uplifting, social idea. It aims to so adjust conditions as to make life worth living, to impress the people with the value of beautiful surroundings, to remove gloomy environments, to eliminate selfish disregard of the neighbour's welfare, to awaken a realization that the happiness and prosperity of a nation lie in securing for its people a full measure of nature's gifts.

We are glad to say that the value of town planning is being realized and that, thanks to the propaganda of the Commission of Conservation and Mr. Adams, municipalities throughout Canada are taking up the matter seriously and thoughtfully. Admirable as the ideas incorporated in a town planning scheme are, they by no means limit themselves to application in our urban districts merely; the value of planning ought no less to be recognized in the nation as a whole. There must be such conditions produced as will give to our human resources a higher value, and this is what town planning aims to do for the centres of population. Nation planning can produce like results throughout the nation. The rural districts as well as the urban, must be made to conform to the ideas of planning.

* * *

This is precisely what Mr. Adams pleads for. He urges the placing of a higher value upon our human resources. In Canada our natural resources are, to all effect, unlimited. We need human activity to obtain them and human ingenuity to put them to use. We aim at increasing production. What counts most largely in productivity is a conservation of life, so far as it implies a development of the qualities of efficiency and of the capacity to make the best economic use of the resources on the part of the people. To secure that conservation our first task, states Mr. Adams, is to apply scientific methods to the planning of land, which means laying out of our national territory in such a way as will place the highest value on the human element by producing improved facilities for co-operation, distribution of products, carrying on of rural industries, education, and so on—all of which can only be provided if land is planned to secure better means of communication and closer settlement, and if more encouragement is given to the producer and less to those who exploit the producer.

The matter of planning is many-sided and involves a great many problems, each in itself comprehensive. Such things as taxation, good roads, the elimination of speculation, sanitation, prevention of disease, education, social intercourse, rural credit and rural industry—all of these, with as many others, must be given the most serious and considerate thought. Only when all have been solved to more or less completeness, can it be said that an attempt has been made to plan the nation. There is plenty of scope offered for the engineer and for the practical man of affairs. Their influence will be required and will be sought, for it is through them alone that many of the problems can be comprehended.

The modus operandi is itself an intricate problem. The question is:—Is the problem too great to be dealt with effectively? It is, if we try to plan Canada from Ottawa or Ontario from Toronto. We must plan first to secure right development and settle the principles of procedure in central governments, but greater responsibility for administration must be placed on local authorities.

Need of C.S C.E. Annual Meeting in the West

THE invitation to the Canadian Society of Civil Engineers to hold the next annual meeting in Calgary was very cordially received at the recent meeting in Montreal. It was strenuously supported by the new president, Lieut.-Col. J. S. Dennis, who, although an Easterner by birth, spent forty-four years in the West. He is a most enthusiastic believer in the possibilities of the Western provinces, and, as one member remarked, the invitation has the advantage of a friend at court when the question is discussed by the Council. It was suggested that a summer convention might be possible, instead of the annual meeting, but the backers of the invitation did not regard this proposal with favor.

The principal object in holding the annual meeting in the West is to get into closer relation with members who are so far removed from headquarters as to feel but little interest in the society. This point was emphasized in the speech of the retiring president, Mr. G. H. Duggan. It is a difficult problem to solve satisfactorily, and one that is inherent in a society with members scattered throughout the Dominion. The establishment of branches, particularly in the West, has resulted in a large addition to the membership. Contrasting 1887 with 1916 the increase west of Port Arthur has been comparatively very large, but this has to a certain extent increased the difficulty. Mr. Duggan dealt very frankly with the position, and made several suggestions in the direction of increasing the interest of such members in the general work of the society and of building up a strong national organization.

In view of criticisms which have come from the West it would undoubtedly be a wise move to hold the annual meeting in Calgary—this being the second time that such a gathering would be held west of Port Arthur. It would consolidate the position of the society in our Western provinces, and show that the Council are not so oblivious to the claims of the distant members as has been asserted. There are many difficulties in thus removing the locale of the meeting from Montreal, but it was evident from the tone of the speeches made in reply to the invitation that the latter will receive a more than sympathetic consideration.

Organization of Saskatchewan Branch C.S.C.E.

After a number of organizing and committee meetings, the Saskatchewan branch of the Canadian Society of Civil Engineers was formed at a meeting held in the City Commissioner's office at Regina on January 30th, the branch to include every member of the society residing in Saskatchewan.

A list of officers was presented by a nominating committee to be submitted to letter-ballot, which will be voted upon at the next regular meeting. The officers comprise a chairman, vice-chairman, secretary-treasurer, and five members of executive committee. The following names are suggested: For chairman, Mr. L. A. Thornton, of Regina; vice-chairman, Mr. G. D. Mackie, of Moose Jaw; executive committee: Messrs. H. S. Carpenter and E. G. Montgomery, of Regina; Mr. T. C. McNabb, of Moose Jaw, and Prof. A. R. Greig and Mr. C. J. Yorath, of Saskatoon; for secretary-treasurer, J. N. de Stein, of Regina.

Besides the regular meetings, a large summer meeting will be held alternately in the various centres of the province, for this year Saskatoon having been chosen.

An advisory board will be nominated to represent each branch of the engineering profession in the province, which committee will give professional advice to members requiring such and will also report to the council in all professional matters where the standing of the profession is involved.

Canadian and International Good Roads Congress at Ottawa

After consideration, it has been decided to hold the fourth Canadian and International Good Roads Congress on April 10-14 at Ottawa. It had been originally intended to go to Winnipeg this year, but some difficulties arose and it was found impossible to accept the Western invitation. One reason for going to Ottawa is that it will enable closer relations to be established with the Federal Government in connection with good roads; it is also a convenient centre for Ontario and Quebec delegates. As usual, the papers will cover all phases of road engineering, construction, materials, costs, and methods. On the same occasion the annual meeting of the Dominion Good Roads Association will be held, at which consideration will be given to a proposal to reorganize the association on a legal basis by introducing a bill for Dominion incorporation. It is believed that this will enable the Association to extend its operations.

Dr. Coleman Will Address Toronto Branch C.S.C.E.

The Toronto branch will hold its regular monthly meeting in the Chemistry and Mining Building of the University of Toronto on Tuesday, February 13th, at 8 p.m., when Dr. A. P. Coleman will deliver his lecture on "Labrador Revisited." Dr. Coleman has made two trips to the wilds of Labrador and has secured many beautiful slides, which he will present on Tuesday night. As this meeting will be of general interest, the executive extends a cordial invitation to the members to bring their lady friends. The membership lists of the Toronto branch are being revised, and the secretary will be pleased to hear from any member of the Canadian Society of Civil Engineers residing in Toronto who has not been getting notices of the meeting.

General Specifications for Concrete Highway Bridges in Ontario

As an appendix to the annual report on highway improvement in Ontario, the Department of Public Highways has recently published a set of general specifications for concrete highway bridges, in accordance with which every concrete bridge constructed by the corporation of a county and every such bridge exceeding 20 feet clear span constructed by the corporation of a township, must be designed and built, as provided by the Municipal Amendment Act, Ontario, 1916. These specifications, as well as covering in detail the design and methods of construction of all concrete bridges, embrace the conditions governing the selection, grading and proportioning of the materials, the mixing and placing of concrete, and the arrangement of forms and centering. From these specifications are extracted a few of the more prominent items which must govern concrete bridge design in Ontario:

The general type of concrete bridge shall preferably be as follows, but it is understood that the limiting lengths are not absolute, and may be varied as occasion permits:

(1) A concrete arch, or concrete abutments with slab covering for spans up to 18 feet.

(2) A concrete arch, or concrete beam bridge for spans from 18 feet to 40 feet.

(3) A concrete arch fôr spans exceeding 40 feet in length.

For short spans on main highways, a clear width of roadway of 18 or 20 feet is desirable and this width should not be less than 16 feet on longer spans. The clear distance between the inside edges of handrail shall be at least four inches greater than the clear width of roadway.

Unit Stresses

All parts of the concrete structure shall be proportioned so as not to exceed the following unit stresses in pounds per square inch for stone or gravel concrete:—

Extreme fibres of beams and slabs for bending	650
Columns whose length does not exceed 15 times the least width	500
Hooped columns, whose length does not exceed 15 times the least width	650
Shearing stress in concrete	60
Bond between plain steel and concrete	60
Bond between deformed steel and concrete	100
Tension in structural steel	16,000
Hard steel, tension	20,000

The bearing strength of soils under foundations shall, if possible, be based on actual test, but where this is impracticable, the following shall be used:

Rock in thick beds	25 tons per sq. ft
Strong gravel and coarse sand, dry	8 tons per sq. ft.
Compact sand or firm clay, dry	4 tons per sq. ft.
Clay, moderately dry	3 tons per sq. ft.
Clean, dry sand, not cemented	2 tons per sq ft
Wet clay	1 ton per sq. ft.
Quicksand and wet, yielding soils ...	0 to ½ tons per sq ft

Permissible Loading

Each structure shall be designed to carry the following loads:

(1) A dead load consisting of the total weight of concrete, steel and other material therein, including the weight of earth or other superimposed filling; the weight of concrete to be assumed at 150 pounds per cubic foot, and earth fill at 100 pounds per cubic foot.

(2) A uniform live load expressed in pounds per square foot of floor surface, covering the whole or any part of the bridge.

(3) A concentrated live load expressed in tons, passing over any portion of the bridge, on two axles at 10 feet centres and 6 feet gauge, two-thirds of the load to be carried on the rear axles.

(4) For floor slabs, a concentrated load expressed in pounds, midway between stringers or beams, and resting on a base one foot square and assumed as supported by a transverse strip of slab one foot wide.

Bridges will be classified according to loading as follows:

(Class A) Bridges suitable for main county roads.

(Class B) Bridges suitable for light country traffic.

(Class C) Bridges suitable for heavy and concentrated traffic.

	Uniform live load Lbs. per square foot	Concentrated live load	Floor load Pounds
Class A	100	15 tons	3,000
Class B	100	10 tons	3,000
Class C	135	20 tons	4,000

Proportioning Parts

In designing reinforced concrete arches they shall be proportioned by the method of analysis based on the elastic theory of the arch, to carry the dead and live loads specified. At least two conditions of live load must be assumed, the live load covering the entire arch, and covering one-half the arch. The line of pressure in arch rings of plain concrete shall pass within the middle third of the ring. Reinforced arch rings shall be reinforced with at least one-half of one per cent. of steel at the crown, and preferably one per cent. shall be used. At all points there shall be sufficient steel to resist the bending moment without reliance on the surrounding concrete.

In determining bending movements due to external forces, it shall be assumed that all beams, girders and slabs are simply supported at the ends, no allowance being made for continuous construction over supports. Bending moments shall be determined in accordance with approved theory. If, contrary to the foregoing assumption, negative moments are developed at the supports due to monolithic methods of construction, sufficient steel reinforcement shall be placed in the top of beams, girders and slabs to resist the stress.

The range of temperature assumed in the designing of arch-rings shall be + 50 degs. F. Expansion joints shall be placed in walls and footings at intervals not exceeding 40 feet; also in the spandrel walls of arches at the haunches and the crown, but special steel reinforcement may preferably be employed to resist temperature stresses. Expansion joints are to be so keyed as to prevent lateral displacement.

Structures or parts of structures in which are used patented or proprietary materials, or systems not capable of exact or satisfactory analysis, shall have a safety factor of four, after 30 days, based upon actual test.

Concrete shall be known as "fine concrete" and "rubble concrete," the former to consist of a mixture of gravel and cement, or of broken stone, sand and cement; the latter to consist of "fine" concrete with large stones imbedded therein.

The following clauses govern the proportioning of materials: The proportions of materials to be used in mixing "fine" concrete shall be by measure, loose, and shall be as follows:—

Gravel Concrete

(a) Abutments, piers and wing walls: One part of cement to six parts of gravel.

(b) Arches from the springing line, floor slabs, beams and columns: One part cement to five parts gravel.

(c) Floor slabs used as pavements, parapet walls and handrails: One part cement to four parts gravel.

Broken Stone Concrete

(d) Abutments, piers and wing walls: One part cement, two parts sand, and five parts broken stone.

(e) Arches from the springing line, floor slabs, beams and columns: One part cement, two parts sand and four parts broken stone.

(f) Floor slabs used as pavements, parapet walls and handrails: One part cement, one and one-half parts sand, and three parts broken stone.

The proportioning of materials may be varied by the engineer from the foregoing, on the basis of voids in the aggregates, to secure a compact mixture, but the amount of cement is also to be determined by the strength of mortar required. In no case is less cement to be used than is needed to fill the voids in the sand or fine aggregates when dry; but the interstices of the coarse aggregates should be measured, and at least sufficient mortar used to fill the voids and give a 10 per cent, surplus.

Bonding New Work to Old

In placing concrete where mass work is interrupted before its completion or at the close of the day, a sufficient number of well wetted one man stones shall be placed so as to project above the concrete surface to ensure bond with succeeding concrete work. Before the work of depositing concrete is resumed this surface shall be thoroughly wetted and cleansed of foreign material and laitance. A mortar consisting of one part cement to two parts sand shall then be deposited on the wetted surface to a depth of about one-half inch when the work of placing concrete shall be resumed. Where thin sections of concrete work are interrupted or at the close of the day no concrete shall be deposited until the surface has been roughened, thoroughly wetted and cleansed of foreign material and a mortar of one part cement to two parts of sand spread over the wetted surface to a depth of about one-half inch.

Surface Finish

The surface is to be so worked that when the forms are removed it shall be smooth and free from voids. If defective in this respect, the surface may be grouted with mortar of equal proportions to that used in the concrete, care being taken to remove all loose sand and dead material, and under such further conditions as may be considered necessary by the engineer. If a "rubbed" finish is specified, the surface, when the forms are removed and cavities filled, is to be wetted with a grouting composed of one part of Portland cement and two parts of fine sand, and the whole gone over with a piece of sandstone or corundrum, to remove all irregularities. A "washed" finish, if specified, shall require that, about ten hours after the concrete has been deposited, the forms shall be removed, the surface washed or scrubbed with clean water or a weak solution of muriatic acid, to remove the cement and expose the finer stone.

Concrete in arches is to be put in place continuously until the ring is completed when possible. When it is necessary to discontinue work, or when the work is laid in alternate sections, joints are to be clean cut and truly radial from the centre at that point. Work may be roughened, but is not to be left with an uneven or slanting surface, or with loose material covering it.

Concrete Floors for Steel Bridges

The floor slabs for the roadway may be of either one course or two course concrete. Where two course concrete is used, the wearing surface shall be one and one-half inches in depth, mixed in the proportion of one part by measure of cement, to two parts of sand. The sand to be clean, sharp, of varying size grain, and free from loam, earth or other impurities. The wearing surface shall be applied to the concrete base before the latter has set so that a perfect bond between the two will be secured. Where one-course concrete is used, the proportion of cement shall be not less than one part of cement to one and one-half parts of sand and three parts of broken stone; nor less than one part of cement to four parts of gravel. The surface of the slab shall be floated with a wooden float until smooth and even, and shall be finished with a dotting wheel, or as directed by the engineer. Irregularities from which water will not drain, shall not be permitted. Sidewalks shall be constructed of two-course concrete.

The thickness of concrete shall in general be not less than 6½ inches at the centre and 5½ inches at the sides, but shall be such as will, with the addition of steel reinforcement, fully provide for the allowed stresses and loading. The surface is to be truly and uniformly curved with a camber of about one inch from side to centre, and to an approved template supplied by the contractor for this purpose. Upper flanges of steel stringers are to be stayed by concrete at least one-half inch below the top of the stringers, unless otherwise required by the engineer.

The metal with which the concrete floor is to be reinforced shall be expanded metal, wire netting, steel bars or other metal approved by the engineer, and is to be completely surrounded by concrete. It shall be so placed within the concrete and shall be of such tensile strength as to fully provide for the specified loading.

Forms

In proportioning forms and centres, concrete is to be regarded as a liquid of its full weight for vertical loading, and half its weight for horizontal pressure. Exposed surfaces must be of dressed lumber, well-fitted, preferably tongued and grooved. All formwork must be of ample strength, well supported and braced. Arched centering must be so arranged that it may be lowered by the removal of wedges or other suitable device. All framework is to be securely bonded by approved wire, in general No. 9, or by steel rods, if so directed by the engineer.

To prevent concrete from sticking, the forms for exposed surfaces shall be oiled or soaped on the side next the finished work. If soap is used, it shall be mixed with enough water to make a thin jelly.

The General Plans for Steel and Concrete Highway Bridges and Abutments, as issued by the Department of Public Highways, shall preferably be used where such standards apply.

Reinforced Gypsum for Roof Decks a New Development

GYPSUM in some form has been used for ten years or more as a roofing material. It presents certain advantages which have made its application for this purpose desirable. The light weight of gypsum is its most important merit. The small dead load of a gypsum roof results in a very considerable saving in the roof trusses and supports, structural frame, walls, foundations and footings. The cost of erection and freight and teaming charges are also very materially decreased by the use of a light material. Gypsum roofs have admirable fire-resistant and incombustible qualities and will not warp, expand, crack or spall during fire. They possess low heat conductivity, so that in buildings where moist air is in excess, there is little trouble from condensation and a warmer roof in winter and a cooler interior in summer is assured.

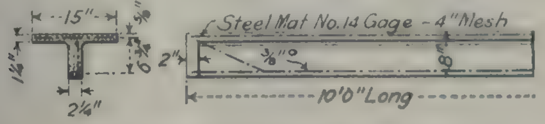


Fig. 1 - Details of reinforced-gypsum T-beam.

Gypsum lends itself to reinforcement with steel similarly to concrete and in all its application to roof surfacing this has been done. Originally gypsum roofing was produced in factory-cast solid reinforced tiles, 30 ins. long and 3 ins. thick, weighing only 13 pounds per square foot, and which are set between steel tees laid on the purlins. These have been used for years in cotton and textile mills, foundries or similar buildings where condensation on the under side of the roof surface is liable to cause inconvenience and trouble.

Development of Gypsum Tiles

To eliminate the steel tees, tiles were developed to span between purlins, made of a new structural material called "Structolite," which is a dense, strong, light-weight gypsum that sets and can be removed from the mould in thirty minutes after being poured. The full working strength is attained in twenty-four hours. The weight is 77 pounds per cubic foot, about half as much as concrete, and the ultimate compressive strength averages 2,000 pounds per square inch. These tiles are made in lengths of 4 feet to 6 feet, and are of channel section with diaphragm webs transversely across the ends and middle. They are laid with the flat surface uppermost. The reinforcing consists of steel rods in the joists and mesh in the slabs. These tiles weigh 14 to 15 lbs. per square foot and are capable of sustaining a safe load of 100 lbs. per square foot.

Experiments have been conducted to determine to what extent gypsum can be reinforced with steel and marketed as a roofing material in long spans, either in factory-made units or units made on the job. The result has been the development of gypsum tiles designed to span from truss to truss and thus decrease the structural steel cost by eliminating both purlins and tees. The length of these units requires manufacture at the site, since factory cast slabs would be liable to injury during transport. A roof of this nature was recently applied in the building illustrated in the accompanying cuts and this is the first time that gypsum has been reinforced and used like concrete for such long spans.

Long Span Gypsum Slabs

The gypsum tiles in this case are of 10-ft. span and their design was developed from the information gained from exhaustive tests, comprising the compressive strength, modulus of elasticity, bond strength, upon numerous rectangular and T-shaped beams of 6 and 16 ft. spans. Figure 1 shows the type of beams adopted in the factory alluded to, which was built for the Walker Manufacturing Company, of Racine, Wis., U.S.A. They were of T-section, 15 inches wide, 8 inches deep, and 1¼ inches thick for the slab and 2½ inches for the rib. The ends are closed with diaphragms 2 inches thick. They are reinforced with two ⅜ in. rods on the bottom of the rib, one of these being bent up at the ends as a shear rod and looped to increase bond stresses. In the slab is embedded a steel wire mat of No. 14 gauge, 4-in. mesh.

The building of the Walker Manufacturing Company is of steel frame construction, covering an area of 190 x 200 feet, with a saw tooth roof. The columns are spaced at 20-foot centres in both directions and a jack truss midway between the columns reduces the roof-tile span to 10 feet. The tiles were moulded at the site, hoisted into position and after placing were covered with a composition roof covering. The slabs are carried by light steel trusses for the saw-tooth portions and by steel purlins for the flat portions, the supporting steel being placed 10 inches from centre to centre. The flat roof has a pitch of 1½ inches in 12 inches.

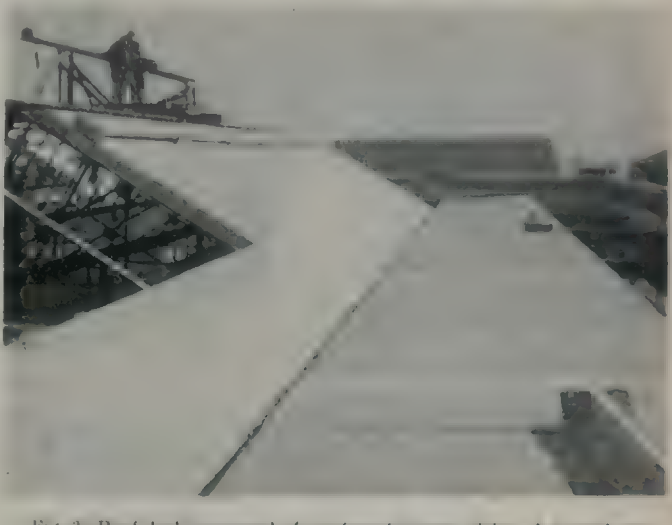


Fig. 2 Roof deck composed of reinforced gypsum slabs. A typical unit is seen in the lower right hand corner. These beams span from truss to truss, eliminating purlins

Methods of Casting Units

For the manufacture of the slabs, collapsible wooden moulds were set up in a yard outside the building. The gypsum was packed in bags of exactly the weight required, so that two bags were used to one mould. In this way improper proportioning was almost impossible. The work was systematized, so that each man of the gang had a specific job and followed the man before him from mould to mould. The forms were oiled with paraffin by one man who also placed the reinforcement on small gypsum spacing blocks set on the bottom of the box; the sacks of gypsum were carried from the cars on an adjacent siding by two men who left one sack untied at each end of the mould; one man filled the measuring buckets at each end of the mould with water; two moulders made the mixture and poured it in the mould; one man adjusted the reinforcement, placed the wire mesh in the slabs and struck off the top surface even with the box. After ten or fifteen minutes, three form wreckers took down the collapsible sides of the forms, cleaned and reassembled them. The tiles having set were carried to a push car and unloaded in position below their permanent locations. The slabs were taken from the moulds fifteen minutes after being poured and were walked upon in three hours. The triangular end walls of the saw-tooth portion were poured on the flat parts of the roof as monoliths and then raised to position. The thickness of these walls was 3 inches.

Retarder Controls Time of Set

One great advantage in the use of gypsum is that the time of setting can be controlled by the use of a retarder, so that any desired speed can be attained, depending on the number and the skill of the workmen. In connection with this building, sufficient retarder was incorporated in the gypsum at first to give the workmen sufficient opportunity to learn their duties. The retarder was decreased more and more as the men became proficient, until the production increased from 600 to 2,800 square feet per day. At capacity the slabs were moulded at the rate of 300 square feet per hour. The entire job, entailing 32,000 square feet of roof, occupied sixteen days.

Can Be Moulded in Freezing Weather

This type of roof is adapted for rapid erection in all kinds of weather. The reinforced gypsum is designed to attain full strength when wet and hence operation can be carried out in wet weather. For example, tiles moulded at night can be placed the following morning although exposed to rain all night. One of the most interesting points about "Structolite" is that it can be moulded in freezing weather, the material generating sufficient heat within itself to prevent it from freezing until it has set. The light weight of this slab—17 lbs. per square foot—keeps the amount of steel to a minimum, about 5½ lbs. per square foot of floor area. The cost of the steel framing to hold the slabs in place was less than 5½ cents per square foot.

This type of roof presents numerous advantages. It is light in weight, resulting in a saving in the truss work and steel framing; it can be rapidly erected in all kinds of weather; its low coefficient of conductivity prevents loss of heat through the roof, reducing the cost of the heating system and saving fuel, and eliminating condensation; the white smooth under surface reflects light; it is economical since the slabs are inexpensive and the supporting frame work is of minimum size.

Strength Tests

Before accepting this construction, five sample T-beam roof slabs similar in detail to the designed T-beams, were made and tested. Some of the specimens were less than 24 hours old at the time of the test and all of them had been exposed during the previous night to a heavy rain. In consequence the gypsum was in such a condition as to make tests especially severe. Each roof beam was placed on a solid support giving a bearing of 2 inches at each end and a span of 9 ft. 8 ins. A distributed load was piled from the centre towards the bearings in increments of 150 lbs. The following table shows the test loads applied.

Sample No.	Load applied	Load per square foot	Deflection inches	Remarks
1	2,200	200	0.034	At these uniformly distributed loads there was no sign of failure.
2	2,400	218	0.070	
3	2,200	200	0.034	
4	2,200	200	0.034	
5	2,400	218	0.070	

These reinforced floor beams were designed to carry a uniform distributed live load of 50 lbs. per sq. ft. with a safety factor of four.

After the foregoing tests, the total loads were increased to 3,500 lbs., but other than the manifestation of horizontal shear cracks there was no sign of failure.

The weight of these long-span reinforced gypsum roof slabs is 17 lbs. per square foot. When the effect of a continuous rather than a beam ceiling is desired, the same slab can be made in H-section with a bottom flange similar to the top flange. In this case the beams weigh about 22 lbs. per square foot and have the same carrying capacity for live load.

Engineering and Civic Progress

A FEW months ago the Chicago Association of Commerce offered prizes for essays on selected engineering topics prepared by graduates and undergraduates of technical colleges in 1915 and 1916. The awards have recently been announced, and through the courtesy of the Chicago Association of Commerce we are permitted to make abstracts of the prize-winning papers. An adaptation of the first prize monograph is given herewith. Portions of the other essays will be presented in a later issue.

Under the caption, "Engineering and Civic Progress," Harvey T. Hill discusses the place of the engineer as a community builder and the greater opportunity that is coming to him for more influential public service:

Too often men are of the opinion that the duty of the engineer is to be a student and master of things, and that he does not need to possess a forceful personality combined with executive ability. How such a false cloak as this could have been enveloped about our engineers is a puzzle. Nevertheless, we must face the fact from many quarters. But with it thus, thanks must be extended to the engineers of the past who have uncompromisingly held to the truth—truth founded not upon mere guesswork, but truth decided by a process of logical thought. This one quality of the engineer has done more to influence the public to entrust him with executive positions as well as the work of planning outlines for both social and civic improvements.

A feeling is becoming prevalent that the same plan of careful forethought which has solved problems of engineering correctly should be applied to a wider field. The old idea was that the place for the engineer in the solution of civic problems was that of an advisor. He was considered a good man to consult once in a while, but should not be given power to execute his expert knowledge. Quite often those who went to him for advice were not competent to appreciate the valuable information he could give. As I have already said, this attitude is changing, until to-day we find the engineer being placed in positions of responsibility, where he executes as well as plans for civic improvement.

Every Position Should Be Filled By an Expert.

Mr. Horace J. Bridges said, in a recent talk on the subject "Can Efficiency Be Combined With Democracy?" that there should be laws passed allowing only men to be candidates for office who have special expert training fitted for that office. He also said: "Expert equipment for the particular job to be undertaken is what makes a real democracy. Who would think of the head of a health department being other than a doctor? Who would think of a states attorney being other than a lawyer?" It is a pleasure to say that these positions are generally logically filled as far as the profession of the one chosen is concerned.

What about commissioners of public works, positions that demand the service of an experienced engineer rather than simply an expert politician? Yet these offices are in nearly all cases filled with men of a purely political stamp. Still another class of misfits are our county commissioners, who have charge of awarding thousands, and sometimes millions, of dollars' worth of construction of highways, bridges, etc. Here, again, the chair of the frank, honest, uncompromising engineer is filled by the clever politician.

These few fields that have been mentioned typify well how our present form of politics, in many cases, retards the efficiency of our government. As one passes over these facts he is led to ask whether the ever-increasing cry for efficiency will not soon bring about a decided change that will put the right man in the right place.

When our attention is diverted to the newer developments of civic life it is found that better conditions exist, and that the engineer is receiving more nearly his just dues. To bring out clearly the bright side as contrasted with the dark that has just been mentioned, I shall discuss in some detail the following: (1) Civil service; (2) city planning; (3) city managers.

Civil Service Eliminates the Unworthy.

The civil service examinations tend to accomplish, in the departments in which they are held, the end which Mr. Bridges pleads for in all civic positions, which is to fill every position by an expert. The scope of civil service, as it is related to engineering, is broadening each year. Already the far-seeing hope that soon candidates, as well as applicants, must prove their ability to execute the duties of the position for which they seek before they will be considered as candidates for the position. Large and small corporations demand special fitness in behalf of their employees. If such is the ideal of business it should, and will eventually become, the ideal of political and civic life.

City Planning By Engineers.

The city planning systems which have recently been developed, and which are being developed, impress upon us the dependence of civic progress upon the engineer. It requires an engineer's mind to plan new transportation systems, new street systems, new parks and other places of recreation. Without a plan you cannot execute. Mr. Nelson P. Lewis, chief engineer, Board of Estimating and Apportionment of New York City, in his recently published book, "The Planning of the Modern City," discusses at length city planning from the viewpoint of the engineer. He brings out the engineer's side of the work, and shows him as the predominant factor in the installation of such plans.

Notwithstanding all the good work of the engineer, the public is often prone to think of the mayor or the city council as deserving of all the credit of the installation of a new city plan. However, those who are thoroughly acquainted with this work recognize the engineer's part in such accomplishment as of the greatest consequence.

City Managers Are Generally Engineers.

One of the newer improvements in the execution of city affairs has been the incorporation of the city manager into the list of city officials. In the few years since this scheme was originated it has found its way into many of the large cities of the United States. This type of work has opened a new field of public usefulness to the engineer. In the search to find the most capable man to fill these important positions the engineering field has been the hunting ground. In the majority of cases it has been the men of engineering training and experience who have qualified to carry on the work. Dr. Frank Crane emphasized this thought in a recent article on "The Engineer," published in the Contract Record of Nov. 15, 1916, p. 1089, when he stated: "We need the engineer to manage a city as economically and smoothly as if it were a manufacturing plant."

Community Work for Engineers.

The author develops the relation of the engineer to chamber of commerce or board of trade organizations. As these commercial clubs are becoming more and more interested in the commercial, civic, and industrial growth of the community which they represent, engineering advice is becoming indispensable, and many of the accomplishments of the chambers of commerce have been credited to the efficient work of the engineering members or to the engineers in the employment of the chambers.

In conclusion, the author reminds the engineers that the world is recognizing their ability more and more each day, especially in activities that pertain to improvement of civic life; also that indications predict that the engineer is to be prominent as a community builder in the future.

A Conference on Road Construction for County Road Superintendents and Engineers

THE third annual Conference on Road Construction for County Road Superintendents and Engineers will be held under the auspices of the Ontario Department of Public Highways at the Parliament Buildings, Toronto, from March 27 to 30. These annual conferences, attended by the road superintendents, have been found a successful means of obtaining the uniformity of methods and the personal co-operation between the engineers of the Provincial Department of Highways and municipal road superintendents, which are essential for efficient road construction and maintenance in Ontario. Short addresses are given by the engineers of the department on subjects of vital interest to all road builders, after which the meetings are open to informal discussion, the interchange of ideas and experiences being found most bene ficial to all. While particular attention is paid to questions pertaining to county road construction, the general features of highway improvement receive consideration. Different types of pavements are discussed and time devoted to problems arising therefrom.

It is felt that to bring county officials together at one time for the purpose of an intimate talk on practical methods will serve a number of useful purposes; that it will give a considerable amount of direct instruction to county road officials; that it will lead to greater uniformity of work throughout the province; that it will tend to a clearer understanding of the requirements of the Department; that it will lead to an exchange of experience among the County Engineers; that it will bring the county officials into acquaintance with one another, and will lead them to inspect work completed or in progress outside of their own counties; and that a broader understanding of the work will result.

At the coming conference, the program will contain a large number of papers covering all features of highway work, prepared by prominent engineers and superintendents. The following list includes some of the important papers:—

Introductory Address, by Hon. F. G. Macdiarmid, Minister of Public Works and Highways.

Departmental Requirements Regarding Annual Returns, by W. Huber, A. M. Can. Soc. C.E.

The Transportation of Materials, by Geo. Hogarth, O.L.S., A. M. Can. Soc. C. E., Provincial Engineer of Highways.

Maintaining Earth and Clay Roads, by A. A. Smith.

Highway Bridges, by Geo. Hogarth, O.L.S., A. M. Can. Soc. C.E.

Culverts, by Arthur Sedgwick.

Dust Preventatives and Bituminous Binders, by G. C. Parker, B.A.Sc., A. M. Can. Soc. C.E.

Important Details in Oiling and Tarring, by W. Huber, A. M. Can. Soc. C.E.

The Highways Laws of Ontario, by W. A. McLean, M. Can. Soc. C.E., Deputy Minister of Highways.

Increasing the Safety of Highways, by W. H. Losee, B.Sc.

Repairing Gravel and Stone Roads, by R. M. Smith, B.Sc.

Reducing Construction Costs by Increased Efficiency, by W. Huber, A. M. Can. Soc. C.E.

Roads, Foundations and Drains, by R. C. Muir, A.M. Inst. C.E., A. M. Can. Soc. C.E.

Concrete Roads, by H. S. Van Scoyoc, Chief Engineer, Toronto-Hamilton Highway Commission.

The Engineers' Club of Toronto

The annual meeting of the Engineers' Club of Toronto was held at their headquarters, 90 King Street West, Thursday, February 1st. The President, Mr. W. A. Bucke, presided.

The annual report of the Board of Directors, presented by the President, stated that in spite of the strenuous conditions which had been imposed by the war, the Club was able to show a profit on all its operations. The members had stood loyally by the Club and made use of the Club services. A number of new members had been added to take the place of those who are overseas, and who are being carried on the books as in good standing. The annual dues and the receipts from the dining room showed very satisfactory increases over the previous year. The membership now stood at approximately 550, of whom 400 are resident members. Of this membership 80 per cent. is classed as technical. While new quarters were desirable from several points of view, the crowded condition of the present quarters made it essential that a new location be obtained as soon as possible. The Club, said the President, occupied a unique position among the Clubs in the city. It is the headquarters for all the important engineering organizations, who not only hold their meetings in the rooms, but have their books housed in the common library.

Centre of Engineering Activity

The Engineers' Club was originally organized with the idea of being the centre around which the engineering and allied activities of the city and district would form. It therefore was gratifying to know that the Club numbered among its members the men most responsible for the large technical problems now under way. We could look forward with confidence into the future and visualize the Club as a great power for good to the technical men of the city and district and the citizens and country generally. The President referred in feeling terms to the recent death of Col. A. M. Hay, President of the McIntyre and Tretheway Mines, and until recently a very active member of the Club.

Mr. Burton read a letter from Mr. Wills Maclachlan, Secretary of the Joint Committee of Technical Organizations, referring to the work to be undertaken by that committee, the primary object of which is to assist in winning the war. He stated that cards would shortly be sent out for the purpose of taking a census of engineers, and he urged the members to give the desired information willingly and promptly. Mr. W. A. Bucke was appointed as the official representative of the Engineers' Club on the Joint Committee.

Mr. C. H. Heys, Chairman of the House Committee, referred to the increased attendance of members during the past year, and emphasized the necessity of new quarters to accommodate the increased membership. He referred also to the economies in the purchase of supplies and in the operation of the Club which had been effected chiefly through the efforts of the Secretary, Mr. R. B. Wolsey.

Seeking New Quarters

In response to a question, the President outlined some of the work that had been done in the direction of securing new quarters, and expressed the belief that in a couple of weeks the directors would have a proposition to submit to the members which would meet with their approval, and which would provide the Club with first-class accommodation, including bedrooms. Although the annual dinner had not been held regularly since the outbreak of war, it was decided that, in view of the number of new members who had joined recently, it would be in the interest of the Club to have a dinner this year.

Messrs. W. A. Bucke, C. H. Heys, Arthur Hewitt, T. S. Young and T. D. LeMay were elected as directors to fill the vacancies, the first four being reelected.

On motion of Mr. Chipman a vote of thanks was tendered to the retiring President, Mr. Bucke, and the directors of the Club for the manner in which the affairs of the Club had been conducted during the year.

Mr. Heys moved a vote of thanks to the Secretary, which was enthusiastically received. The directors recently presented Mr. Wolsey with a beautiful gold watch, suitably engraved, as a slight token of their appreciation of his work.

Heat Transmission Through Window Sash

Results of Experiments to Determine Relative Heat Losses Through Single and Double Glazed Wood, Steel and Hollow Metal Sash

IN the industrial plant of to-day, where so much emphasis is placed upon maximum daylight, the exterior wall surface consists principally of windows, and the heat loss through them is a very important matter. Indeed, there may be a question in certain plants whether the window area is not carried to excess—that is, beyond a point where increased daylight warrants the increased heat loss. In the absence of any authentic data on the relative heat loss through single and double-glazed wood, steel, and hollow metal sash, experiments were carried out by W. S. Brown, under the direction of Arthur N. Sheldon, the results of which are incorporated in a paper read by Mr. Sheldon before the American Society of Mechanical Engineers, and which is presented herewith in abstracted form.

Arrangement of Apparatus.

The test apparatus consisted of an air-tight, cork covered, wood box, one side of which was closed by the sash to be tested. Care was taken to reduce to a minimum the leakage around the sash at its line of contact with the box. An electric heater in the bottom of the test box maintained the desired temperature difference between inside and outside air. The loss of heat was computed from wattmeter readings, and a quantity H—the B.t.u. transmitted per 24 hours per square foot of exposed surface per degree difference of temperature—was determined for each type of sash. Tests were made at approximately 40 and 70 degrees Fahrenheit temperature difference under conditions closely imitating the actual in practice. Temperature control of the air surrounding the test box was obtained by means of a thermostatically-controlled steam radiator. Constant room temperature was desired because any appreciable variation of this temperature would materially affect the accuracy of the results on account of the temperature lag of the materials of which the box was constructed.

Air Circulation Provided.

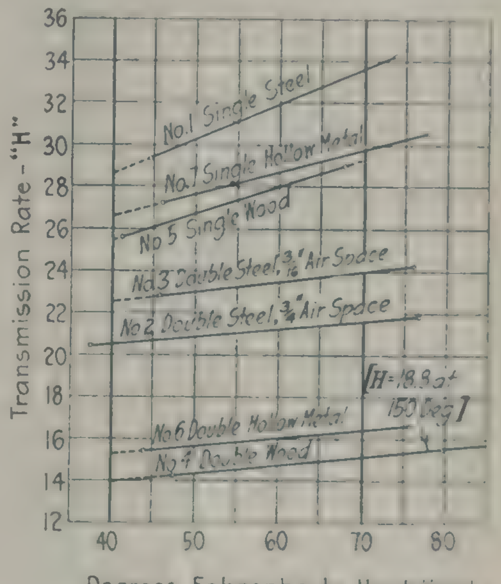
Circulation of air over the surface of the sash to be tested was provided by means of two 12-inch fans, placed one above the other, 4 feet from the vertical centre line of the sash, and which directed air currents against the sash at an angle of 30 degrees, providing a positive circulation over it. Baffle boards secured protection of the back and sides of the box from air currents created by the fans. This was necessary because the heat transmission constants for the box alone were obtained under conditions of still air. The humidity of the air inside the test box was kept as constant as possible throughout the series of tests by means of water-saturated felt, and was measured by means of a wet-and-dry-bulb hygrometer. The humidity remained constant during the period of each individual test.

In order to determine what portion of the total heat was conducted through the sash in a given test it was necessary to subtract from the total the amount lost through the back, sides, top, and bottom surfaces of the box. The latter amount was ascertained by means of "blank-run" tests, the front of the box beings covered in the same manner and with the same materials as the other surfaces. The mode of conducting the test was similar to that of operating the sash tests, except that the fans were not in operation, as the object was to obtain the rate of transmission through the box and covering under the conditions of the main tests—that is, still air for the back, sides, top, and bottom.

Tests were conducted on the following seven samples of sash: 1, single-glazed, solid, rolled steel; 2, double-glazed, solid, rolled steel, with ¾-in. air space; 3, double-glazed, solid, rolled steel, with 3/16-in. air space; 4, double-glazed wood; 5, single-glazed wood; 6, double-glazed hollow metal; and 7, single-glazed, hollow metal sash.

Comparative Heat Transmission Rates.

A resume of the comparative heat-transmission rates is given in tables 1 and 2. The results of the tests have also been plotted in the form of curves, as shown. It is shown that the heat loss is greater through the single-glazed sash than through the double-glazed; that it is greater through metal than through wooden sash; that it is greater through solid metal than through hollow metal sash, and that in double-glazed sash it decreases with increased air spacing between the panes of glass. From the curves it will be noted that the rate of transmission increases with the heat head (temperature difference between outside and inside air), and that there is a greater increase, or steeper curve, for the single than the double-glazed sash.



Comparative heat transmission rates through various types of sash.

To obtain an indication of the paths of heat transmission the temperatures of the glass and sash bars were taken during each test. It was found that for a given temperature difference the solid steel sash bars were hotter than the wooden bars, and by their greater conductivity constituted a direct path for the transmission of heat to the outside air. The hollow metal sash bars were cooler than the solid steel, but warmer than the wood. Indirectly, a further heat loss through the glass itself, in the case of double-glazed sash, can be laid to the solid steel section. Since the amount of heat lost through a given pane of glass depends directly upon the difference in temperature between the two sides, it is evident that in a double-glazed sash the rate of heat transmission through the lights must increase with the temperature difference between the air space and the outside air. The tests showed that the temperature difference between the air in the ¾-in. air space of the steel sash and the outside air was at least 20 per cent. higher than the corresponding temperature difference in a wood sash, evidently due to the effect on the enclosed air of the warmer steel sash bars.

Causes and Prevention of Condensation.

Tests were also conducted to determine the cause of condensation in double-glazed sash and its prevention. Condensation appeared on the single-glazed sash when its temperature was low enough to cool the air confined within the test box below the dew point. The moisture was evident on the inside of the panes. Where condensation occurred in the air space of double-glazed sash, it was always on the outside pane of glass, which, of course, was the cooler one. The wood sash showed no internal condensation, but in the two steel sash condensation was very marked, and was evident in the hollow metal sample. The deposition of moisture seemed to follow no obvious law, occurring on some lights and not on others. As this inconsistency was most pronounced on the solid steel sash, they were selected as the most suitable for investigation. The steel sash, with a ¾-in. air space, was chosen for the preliminary tests, experiments being also conducted afterwards on the hollow metal and wood sash to verify or disprove the previous conclusions.

Table 1. Heat-Transmission Rates at Approximately 40 Degrees F. Temperature Difference.

Sample.	Actual heat head. Deg. F.	H computed at actual heat head.	H corrected to 40 degrees F. heat head.	Relative humidity.	Condensation.
1. Single-glazed solid steel	44.5	29.3	28.5	36	None
2. Double-glazed solid steel — ¾-inch air space	37.4	20.4	20.5	34	None
3. Double-glazed solid steel — 3/16-in. air space	45.7	22.8	22.5	43	Very slight on air-space side of one outside pane and box side of one inside pane.
4. Double-glazed wood ⅝-in. air space	47.3	14.2	13.9	49	None
5. Single-glazed wood	41.2	25.6	25.5	44	Hardly noticeable
6. Double-glazed hollow metal ¾-in. air space	43.9	15.4	15.2	54	On air-space side of one outside pane
7. Single-glazed hollow metal	46.0	27.1	26.4	43	All

Table 2. Heat-Transmission Rates at Approximately 70 Degrees F. Temperature Difference.

Sample.	Actual heat head. Deg. F.	H computed at actual heat head.	H corrected to 70 degrees F. heat head.	Relative humidity.	Condensation.
1 Single-glazed solid steel	73.9	34.2	33.6	28	All
2. Double-glazed solid steel—¾-in. air space	76.8	21.8	21.6	29	Fifteen outer panes out of 20 showed moisture on air-space side
3. Double-glazed solid steel — 3/16-in. air space	76.0	24.2	24.0	30	One outer pane showed moisture on air-space side; one inner pane showed moisture on box side. Three lights showed both the above.
4. *Double-glazed wood — ⅝-in. air space	79.8	15.5	15.1	31	None
5. Single-glazed wood	67.6	28.9	29.3	29	Twelve lights
6. Double-glazed hollow metal ¾-in. air space	75.6	16.6	16.4	36	On air-space side of one outside pane
7. Single-glazed hollow metal	77.7	30.5	29.7	25	All

*A test upon this same wood sash with the inside panes of single-thick plain glass instead of double-thick showed an increase in H of 3 per cent. at 70 degrees F. temperature difference.

Holes were bored through each of several of the outer panes of wire glass, of which some had and some had not shown condensation. Smoke was then blown into the various air spaces through these holes and leaks to the outside or to adjacent air spaces carefully noted. Considerable leakage was observed, either to adjacent air spaces or to the front or back or to a combination of these. It was observed that in lights where condensation was evident the greatest leakage was into the inside of the box, and that in those lights where no condensation occurred the greatest leakage was to the air outside the box. Other lights showed serious leaks to both sides and to adjacent air spaces and also showed condensation.

Experimental Conclusions.

Following this clue, the entire sash was reglazed and holes bored in seven of the outer panes, and in five of the inner panes, thus establishing free communication either to the external cool or to the warmer air inside the test box. All the other panes were carefully bedded and set so as to be air-tight. A test on this sash showed the following results: (a) Lights in which the air space opened to the outside or cooler air only showed no condensation; (b) lights in which the air space opened to the warm air inside the test box showed much condensation. The sash was reversed, with its outer side toward the interior of the test box, and the above results were confirmed.

The explanation is that changes in temperature on either side of the sash cause corresponding, though less marked, changes in the temperature of the air space. The pressure of the combined air, therefore, becomes more or less atmospheric pressure, and air is correspondingly either forced out of or admitted through the drilled holes, and, if a temperature difference is alternately increased and decreased, a "breathing" action obtains in the air space. A similar action occurs through leaks in actual practice, and is due to daily variations in temperature and the longer seasonal changes. Air entering an opening of this kind from the inside, coming as it does from the warm interior of the test box or building, becomes chilled and its relative humidity correspondingly increased, condensation necessarily appearing if the cooling is carried on below the dew point. "Breathing," or a repetition of this process, necessarily results in a gradual accumulation of condensation. Conversely, air entering an opening of this kind from the outside becomes heated, and its relative humidity correspondingly decreased, making impossible the precipitation of any moisture.

The double-glazed wood sash, when tested in the same manner, showed no traces of condensation in any of the air spaces.

A Suggested Remedy.

These experiments indicate that condensation in the air space of double-glazed sash can be eliminated almost entirely by connecting the air space directly to the outside air and at the same time effectively sealing it from the entrance of the warm air within the building. It is suggested that the openings should be very small, equivalent, say, to a 1/8-in. hole, designed merely for a communication between the internal air space and the outside air during temperature changes. This "breathing hole" should be protected from the weather and dirt. Its location seems to be immaterial from the standpoint of elimination of condensation, but a consideration of heat economy would indicate that the bottom of the light is preferable. Whether or not, as a practical problem, this method can be applied to seal the inside panes of double-glazed steel sash, and leave an opening in the outside panes, is worthy of the careful consideration of steel sash manufacturers. The results of these tests should not be construed as indicating that double-glazed wood sash never show interior condensation, but merely that they are superior to steel and hollow metal sash in this respect in the present stage of development of the latter types.

The Necessity for Adequate Methods of Waterproofing in Road Construction

By C. J. Morrison*

IN order to fulfill their requirements, roads must be waterproof, so as to protect them from the flowing, undermining, and penetration of water. The principles of waterproofing are simple, but are neglected, with the result that roads—and often expensive roads—deteriorate and become absolutely ruined and useless through a lack of the appreciation of the necessity of adequate protection from the effects of water. The comparative costs of construction and maintenance show that at the end of five years the total cost of a non-waterproof road and a semi-waterproof road are about equal, but the former is in very bad condition, while the latter shows little deterioration. Similar comparisons for waterproof roads are not yet available. In this article, which is adapted from a paper prepared by the writer for presentation to the American Society for the Advancement of Science, the necessity for adequate methods of waterproofing is considered and the means of securing waterproof qualities are outlined for five general conditions of road construction. Each condition requires a different method of treatment, dependent on location of drains, construction of road, and treatment of surface.

A diligent search for a clear statement of the problem of road construction revealed nothing better than the words of Dr. H S. Haleshaw and Prof. Douglas Mackenzie, and we have therefore taken the liberty of using a portion of their paper read before the Royal Society of Arts as an introduction to this article.

Road Considered as Element of Machine.

There is only one really sound way of approaching the problem of road construction, and that is to regard the road as one element of a mechanical contrivance, of which the wheel is the other element. This aspect of the matter seems too often to be entirely overlooked. Inventors of a wheel and the makers of a road respectively too often treat their part of the problem without reference to the other part, whereas these parts are only two halves of a whole.

More than forty years ago there was translated from the German, by Sir Alexander Kennedy, the "Kinematics of Machinery," of Prof. Reuleaux, and in that work for the first time the true conception of a machine was set forth. We now realize that the action of a rope on a pulley, water in a hydraulic system, or a wheel on a road, might be considered as much cases of mechanical action as that of two tooth wheels working in contact with each other. It was truly said in the above work: "A machine may be perfect, or may contain more or fewer imperfections; it approaches perfection just in proportion as it corresponds to what we have recognized as its special object—the special end for which it has been constructed."

Special Purpose of Roads.

Now the special end for which two elements in the case of a pair (a higher pair, as it is called in the case of rolling contact), viz., the wheel and the road are designed—is that they may run smoothly and in contact with each other, resisting considerable material pressures without permanent deformation and without undue wear or loss of energy.

The ideal condition of things is obviously that in which a perfectly hard and perfectly circular wheel runs on a perfectly hard and level road. It might be said, therefore, that a steel wheel and a steel road would be suitable, as in the case of railway practice. As a matter of fact, quite apart from the practical question of the cost of such a road, there are questions of adhesion, in the matter of gradients as well as steering, that make a metal road quite out of the question. Assuming, then, that a really hard road cannot be obtained, it may be at once said that if a moderately hard road could be kept level and entirely free from all unevenness of surface there could be nothing better than a truly circular metal wheel, and such a wheel, being cheap and durable, would doubtless be universally employed.

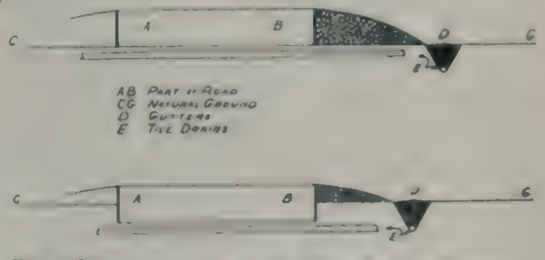


Fig. 1—Drainage arrangements for a road on level ground.

Ideal Road Impossible.

However, a thing so desirable as a truly level surface is exactly what it is impossible to maintain, and it is in order to mitigate the shocks caused by the tendency to deflect a vehicle from its movement in a straight course that yielding material, such as solid rubber or pneumatic tires are employed on the periphery of a wheel. This soft material cannot be used without paying the penalty, not merely of wearing the wheel, but of wearing the road itself, and, as a matter of fact, inasmuch as the contact between the wheel and the road departs from a point in the side elevation, or a line looked at in plan, by so much is wear between the surface in contact introduced.

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* Of Meyer, Morrison & Co., Inc., New York.

In the next place, consider what goes on beneath the surface. If the road is not hard, then a certain amount of deformation must take place.

The injury done by this deformation will depend on two things:

1. The depth to which it extends.
2. The extent of permanent disintegration of the internal substance of the road.

It is, therefore, obvious that, both as far as the surface is concerned and also the body of the road, what is required is a hard, strong substance which presents great resistance to wear, deformation, and disintegration. If it is impossible, on account of expense, to make the whole of a road of such material, then the surface of the road should be of such material, and the body of the road should be bound or cemented together with such material.

Necessity for Waterproofing.

In any case, as the road is exposed to the action of the weather, one of the very first conditions of its efficiency is that it must be waterproof, and that the surface must be sufficiently hard to prevent the formation of mud in wet weather and dust in dry weather.

The term "waterproof" is used here in the broad sense, meaning both the protection of the road from water and the rendering of the road itself impervious to water.

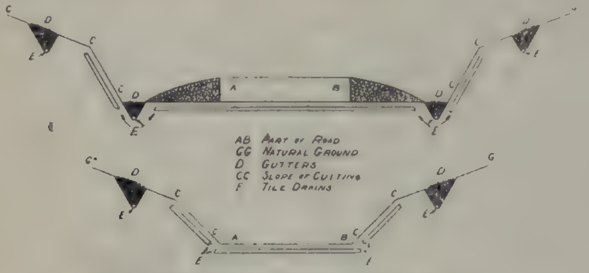

Fig. 2—Method of draining a road in a cut.

Roads must be waterproofed so as to prevent damage from abrasion, from undermining, from foreign substances being washed on them, and from water penetrating the mass of the road. Although water is one of the worst enemies of the roads, the fact seems to have been given little attention, and, as a result, the cost of maintenance has increased enormously. Possibly the condition is due chiefly to the deplorable fact that road-building has been largely in the hands of politicians and contractors instead of engineers.

Last winter hundreds of miles of roads were ruined because they were not waterproof. Water penetrated the body of the roads and froze. The result was upheavals and disintegration. Even the most elementary principles of waterproofing have been neglected.

Conditions Met in Construction.

As the elementary principles of waterproofing have been so completely neglected, it may not be amiss to describe them. Roads are built under five general conditions and combinations of these conditions. The general conditions are: (1) On level ground; (2) on inclined ground; (3) in cuts; (4) on embankments; (5) on the side of slopes.

Roads on Level Ground.

A road built on level ground can be very easily waterproofed by building it slightly above the general elevation, by giving it a crown sufficient to cause any water to flow, by providing ample gutters on each side, by laying sufficient underdrains, and by applying a surface which is impervious to water. This method of construction is shown as Fig. 1. At frequent intervals trenches or drains should be provided to carry off the water from the gutters.

Although it is so simple and inexpensive to properly waterproof a road built on level ground, the precaution is often neglected.

Roads On Inclined Ground.

The conditions usually met on inclined ground are practically the same as on the level, and construction would be the same. However, great care should be taken to provide adequate drainage to carry off the water at the foot of the incline, and it is particularly important at this point that the surface be waterproof. Many roads have been ruined by failure to meet these simple requirements.

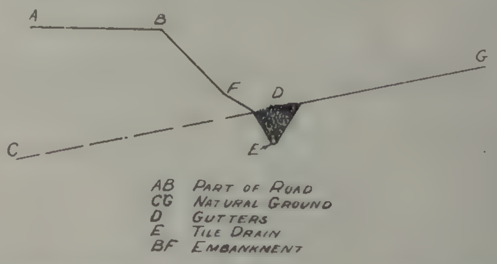

Fig. 3—Road constructed on an embankment. Protection from water.

Road in Cut.

Roads built in cuts are probably the hardest to protect from flowing water, and there is therefore all the more necessity for a hard surface and integral waterproofing. Fig. 2 shows the general method of protecting a road in a cut, and is so elementary that no comment seems necessary. Although so elementary, the methods are quite generally neglected.

Roads on Embankment.

Roads on embankments seldom cause trouble if the most elementary principles are observed. These principles are shown in Fig. 3. The two salient features are to build the road so that it is integrally waterproof and so that the embankment is protected from flowing water.

Road on Side of Slope.

Roads on the sides of slopes should be waterproofed in the same manner as roads in cuts, with the exception that protection from flowing water is necessary only on one side. In both cases the road itself should be integrally waterproofed, as in Fig. 4.

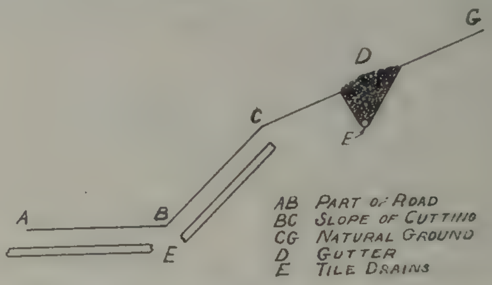

Fig. 4—Drainage principles for a road on the side of a slope.

In view of the object lessons continually before all users of the roads, it seems that waterproofing cannot be neglected much longer. Ruined roads can no longer be explained by the one word, "automobile," but must be charged to the fundamental causes.

If further proof is necessary, it may be found in the official reports from various states. However, these reports cover only non-waterproof and semi-waterproof roads. Thoroughly waterproof roads have been constructed only experimentally and by private concerns.

One state reports less money spent in maintenance over a greater mileage due to concrete roads. Another has discovered that a macadam and a concrete road have cost the same amount at the end of five years, and that the macadam is ruined while the concrete is still good. Other states substantiate these claims.

Conclusion.

For the vast sums of money that are being spent yearly on our highways entirely too large a percentage has been wasted. The trend toward concrete roads is the first step in the direction of permanently good roads. These meet best the requirements for strength and surface. But even the very best material available cannot withstand the destructive effect of water.

Publicity can do much to educate the public into realizing the necessity of properly protecting its investment in roads by protecting the roads themselves. Proper drainage solves a large part of the problem.

There remains only the problem of so treating the material of the road either in the topping or throughout the mass that it will be impervious to water.

A great many test sections of roads have been and are being laid, but up to the present time no practical method has been demonstrated by which this effect can be produced. There is little doubt but that such a road can and will be constructed in the near future, for much time and attention is being devoted to its accomplishment.

Stoplogs vs. Steel Gates for Lasalle Bridge and Dam Contract, Montreal

A CONTROVERSY has arisen in Montreal over stoplogs vs. gates in connection with the Lasalle bridge and dam contract. This was awarded to Mr. T. O'Sullivan, who is desirous of withdrawing from it provided he be compensated for the work done and material on the ground. It appears that Messrs. M. J. Butler and Percival St. George were consulted as to the plans. They recommended an alternative plan, substituting stoplogs for the steel sluice gates; further, that the breast wall should be materially increased in thickness, and a much heavier floor, paved with granite, for the sluice way, be provided. If the latter alterations were carried out, the engineers agreed that the plans, although costly, would be safe. Messrs. Butler and St. George suggested that bids be asked on the alternative plans, and, with the substitution of stoplogs, estimated a considerable saving in cost. This was not done, as Mr. Mercier, the chief engineer of the city, did not approve of the alternative plans.

City Engineer Commends Steel Gates.

Mr. P. Mercier defends the steel gates, and denies that the saving would be as great as estimated by the consulting engineers. In his opinion the stoplog system was objectionable for several reasons. The water would be held back, it is true, but not so easily controlled as by the steel sluices. The logs would be clumsy things to put into position, and they would require the labor of six men, as contrasted with the two men for the steel gates. Mr. Mercier estimates that the wages of the four extra men, supposing they were needed for fifty days of the year, would represent an outlay of $500, or a capitalized amount of $10,000.

The chief engineer also estimates that 200 logs 22 feet long sawed into timber 12 x 15 inches would be required for the purpose. These timbers would have to be thawed free from ice and snow, and then, after holes had been cut in the ice-covered intake, they could be placed slowly in position, all of which labor would be eliminated if steel sluice gates were used.

In concluding his report the chief engineer declares: "A project was submitted to you, the estimated cost of which was $242,000, and I was asked to adopt another plan, the estimated cost of the construction being $220,000, the operation of which would require a capital expense of $10,000 more, without being as advantageous as the other. These remarks were communicated to Controller Cote, and I advised him to adhere to the proposition of your engineers, as I considered it to be preferable."

Stoplogs Would Effect a Saving.

Messrs. Butler and St. George have replied to this report. They state in the course of their letter: "With regard to the city engineer's comments on the use of stoplogs vs. gates, they are certainly prevailing all over this country and the United States. We may say that there are very few Stoney sluices to be found on hydraulic work in this country, but there are innumerable examples of the stoplogs doing much more difficult work than is required at this particular place. The comments as to added labor, etc., being required, and the absurd capitalization of same, would be ridiculous if it were not that it is used to justify waste. Once the aqueduct is filled with water and put into use, the stoplogs raised and piled under shelter, as is usual, never again in all probability would it be found necessary to handle same, except in the case of a possible disaster to the works, in which case they could very quickly be put into place. Whatever possible advantages in manipulation that might be construed in favor of the Stoney sluices over the stoplogs cannot apply to this case, and is only applicable to places such as canals to regulate the quantity of water admitted. Our estimate of saving to be had was based on comparative estimates of cost and not on the figures made by the successful tenderer. Our recommendation to ask for alternative bids was not acted upon. Had it been done this communication would not be necessary."

Present Practice and Regulations Pertaining to Pavement Openings

"PRESENT Practice and Regulations Pertaining to Pavement Openings," was the subject of a paper presented at a meeting of the Citizens' Street Traffic Committee of Greater New York by Professor Arthur H. Blanchard. In this paper the author outlines the attempts made to regulate the cutting of street openings in many municipalities and draws conclusions from observations of current practice that will be applicable to the general conditions obtaining in most municipalities. In the Contract Record of August 30, 1916, under the caption, "The Street Opening Evil," editorial comment was made on the perplexing nature of this problem and the need of more efficient administration and organization in this regard.

Great Variation in Administration

The present unsatisfactory status of pavement openings in many municipalities is due to one or more of the following contributing causes: (1) Lack of centralized administration; (2) inadequate supervision by highway departments; (3) utilization of inefficient organizations and methods for backfilling trenches, making temporary surface repairs, and final replacement of artificial foundations and pavements.

Present practice in administration and organization governing pavement openings varies from absolutely no control by a city official to a thoroughly organized administration. Much trouble is caused by lack of knowledge of sub-surface structures. In the majority of municipalities a few attempts have been made to remedy this situation by requiring owners of sub-surface pipes and mains to file plans of their location. Practically all cities of any size require some sort of permit for making a pavement opening. In many cases, however, the securing of a permit is a mere formality and exercises no effective control over the situation. The amount of deposit required with a permit varies to a remarkable degree, a few places adopting the logical basis of charging the cost of repairing plus a certain percentage for inspection and other overhead charges.

Great variation is found with reference to making repairs of openings by city departments, contractors or public utility companies. In some cases all repair work is done by the permittee. Many municipalities allow the permittee to open and backfill, the city department constructing the artificial foundations and pavements. In a few instances the city does all the work with experienced men, the result being that openings are repaired in an efficient manner and very little trouble results thereafter.

Based on observations of practice in many cities throughout America and Europe, Professor Blanchard submits the following conclusions as applicable to general conditions found in most cities.

Administration and Organization

Pavement openings should be absolutely under the control of the chief of the Roadway Department; all persons, corporations, and other city departments being required to secure permits from the highway department prior to making openings in pavements, except where emergency conditions require such openings to be made in the interests of public health and welfare.

Notices should be advertised, posted, and sent to all interested parties, giving ample warning in cases where streets are to be paved or repaved and containing the provision that charges to the permittee will cover cost of backfilling but not artificial foundations and pavements. The practice of not allowing pavement openings to be made within a certain period after a pavement is laid is believed not to be in the interest of public progress, and is unnecessary if the notice advocated is given and efficient methods of control, backfilling and repaving are adopted.

Plans of sub-surface structures on all streets should be compiled and permits should be granted only after accurate and detailed information has been filed pertaining to all details of sub-structures in connection with the given pavement opening.

Deposits should be required covering cost of backfilling, reconstructing artificial foundations and repaving, which should be based on a schedule of rates dependent upon the character of backfilling, type of artificial foundation, kind of pavement and yardage of the several items. An adequate percentage should be added to the cost of the above items to cover supervision and other overhead charges.

After a permit has been granted excavation should be made by the permittee, and backfilling and repaving done under the supervision of engineers of the highway department and by a flying squadron of experienced men in the employ of the department.

Backfilling and Artificial Foundations

All material excavated, except rock, should be replaced in the trench and, in the process of backfilling, the material should be thoroughly compacted by hand or mechanical tampers or with the aid of water used sparingly, dependent upon the character of soil and kind of pipes. The wise saying of an old road foreman, that two tampers are required for every shoveler in order to secure satisfactory compaction, should be borne in mind in organizing the flying squadron of experienced laborers.

Except in the case of waterbound gravel and broken stone roads, cement-concrete foundations over trenches should be constructed and such foundations should extend six inches beyond each side of the trench and have a depth of not less than eight inches. If the methods outlined above are adopted, it is not necessary to postpone repaving provided climatic conditions are satisfactory for such work.

If temporary repaving is, for any reason, necessary, it is recommended that the backfilling, as above outlined, be carried to the elevation of the top of the artificial foundation and that such materials as small stone blocks, paving bricks laid flat, asphalt block seconds, or hot or cold bituminous concrete should be used for a temporary wearing course.

Repaving

In the process of repaving, it is recommended that the old pavement be cut back three inches on each side of the new cement-concrete foundation. The adoption of this plan will eliminate planes of weakness and will ensure the practicability of making an efficient bond with the old pavement.

Sidewalks

The ground beneath sidewalks in municipalities should be kept clear of vaults and other accessories of buildings. The space under sidewalks should be reserved for the possible future installation of pipe systems which would relieve present congestion of sub-surface structures in the carriageway and reduce the number of openings made in pavements.

Timber in Pier and Wharf Construction

UNDER the above title, the National Lumber Manufacturers' Association have issued a bulletin giving a statement of facts and summary of data in regard to the use of timber in waterfront structures, together with testimony from experienced engineers who have compared its fitness, durability, and cost, with concrete in similar cases. This bulletin, of course, presents the case from the point of view of the lumber manufacturer, but is abstracted here as being of interest:

A consideration of proper pier construction divides itself logically in four general headings, namely:

1. Fitness of the material under consideration.
2. Comparative cost.
3. Durability.
4. Is permanence the controlling factor?

Fitness of the Material Under Consideration

The question of the fitness of timber for use in piers and wharves is one which is agreed upon by practically every engineer having experience in this line of work. No other material can be handled so easily during construction or adapted to so many varied purposes as timber. No other material will permit such easy and rapid changes in water-front structures, as the increase in commerce demands growth in harbor facilities. Timber easily excels in the lack of damage to shipping which may be in contact with the sides of piers or wharves, as in the case of vessels or steamers approaching or moored to a pier.

Comparative Cost

Comparative cost depends somewhat on local conditions, but as a general proposition timber piers cost one-third to one-half as much as concrete piers.

The annual cost, which after all is the important consideration, is approximately the same for both types (a fact not generally known) as brought out in detail by Mr. Jerome Newman, Chief Engineer, State Board of Harbor Commissioners, San Francisco, Cal., in data below.

Durability

Durability of timber for pier construction is dependent entirely on the selection of suitable kinds and grades and on proper precaution to prevent its decay. The efficacy of creosoting timber to prevent its decay or its destruction by marine borers is well established. There are many examples of the durability of properly creosoted timber piers, one of the most striking of which is the Pier No. 6 of the Chesapeake and Ohio, at Newport News, Va., erected in 1883, two hundred feet by eight hundred feet, built on four thousand creosoted wood piles. Timber was treated with twelve pounds of creosote oil per cubic foot. It stands in water infested with teredo, where untreated timber is destroyed in two years and less. Examination in 1915 found original timbers in use and in excellent condition, after 32 years in service.

Is Permanence the Controlling Factor?

Many arguments have been made in favor of concrete pier construction, all of which are based on the fundamental idea of permanence. Setting aside any questions as to the permanence of concrete for this purpose, and there are many, there yet remains the vital question: Should permanence be the controlling factor? Especially is this question of importance when river or lake front development is considered.

Mr. Charles W. Staniford, M. Am. Soc. C. E., stated in a discussion of this question:

"The old wooden pier, as built in New York Harbor up to ten years ago, because it was easily removed and reconstructed, was one of the greatest factors in developing the harbor facilities. Instead of the shipping being compelled to adapt itself to the location and operation of massive permanent structures located along the water-front, as in English and Continental harbors, where there are stone quays and piers, the structures for berthing vessels and taking care of cargoes in New York Harbor were located to meet the conditions of shipping as these conditions developed and increased facilities were required."

Fully developed harbors, such as obtain in Europe, may well consider the building of permanent piers and wharves. The state of the development of harbors in this country, however, will not justify such construction.

Timber Construction Elastic

Discussing modern pier construction in New York Harbor, Mr. Charles W. Staniford, chief engineer, Department of Docks and Ferries, New York, states: "The wooden pier, consisting of a timber deck and floor system supported by timber piles, became the adopted type. It was cheap, durable, and readily adaptable to all classes of shipping. One of the most important characteristics of piers of this type is the ease and economy with which it may be removed entirely, reconstructed wholly or in part, or expanded, at a low cost, to meet the increasing needs of commerce and shipping. A dock or system of docks sufficient to accommodate the shipping at the time it was built, might be found to be inadequate and obsolete within a comparatively short term of years, a complete rearrangement being then necessary.

"With timber structures, this transformation or reconstruction is a simple, rapid, and economical undertaking; it is difficult and costly with structures of stone, concrete, steel, etc. The use of concrete piles, reinforced concrete sub-structures, or similar forms of construction, therefore, would not only have resulted in high first cost of construction, but the difficulty and expense incidental to the periodical removal, reconstruction, or expansion of dock structures of this type, as necessitated from time to time by the growth of shipping, would have rendered harbor construction work, as a revenue-producing municipal investment, practically impossible, and, consequently, would have greatly retarded the development of the harbor."

Mr. William T. Donelly, consulting civil engineer, New London, Conn., Harbor Commission, gives the following opinion: "The pile construction of the pier on each side is considered to be only semi-permanent, and this attitude has been deliberately taken, as, after careful consideration, it was agreed that a permanent structure could easily have a structural life exceeding its commercial or useful life."

Comparative Costs

An estimate of comparative cost is given by Mr. Jerome Newman, chief engineer, State Board Harbor Commissioner, San Francisco, Cal., as follows: "Assuming the cost of a creosoted pile pier at $1 per square foot, with a life of twelve years, and that of a reinforced concrete pier at $3.25 per square foot, with a life of one hundred years, the comparative annual charges for the two types of construction are approximately as follows:

	Creosoted Pile	Reinforced Concrete
Interest at 4½ per cent. ...	$0.0450	$0.1463
Maintenance, assumed	0.0500	0.0125
Replacement, 12 years	0.0681	......
Sinking fund, 75 years	0.0022	0.0077
Insurance	0.0060	......
Total, per square foot	$0.1713	$0.1665

"This would indicate that the annual cost is very nearly the same for the two classes.

"The assumption of 12 years' life for creosoted piling and 100 years for reinforced concrete is hardly justified, though it is true, in the calculation above, I adopted it in making a comparison, merely to indicate in a general way that the annual cost of the two types is nearly equal under unfavorable conditions for the temporary type. There is evidence at hand to prove that properly treated piles may be counted on for a maximum life of twenty years, and fifteen years may be considered a fair average; our experience with reinforced concrete has been too short, however, to enable us to form an intelligent opinion as to its durability when exposed to salt water."

Sources of Trouble in Brick Pavements

Inadequate Specifications with the Absence of Definite Details Responsible for Many Failures.

By Maurice B. Greenough*

THE writer recently examined a brick pavement which showed frequent patches varying in area from one to ten square yards wherein the brick were depressed and badly distintegrated. The pavement had been down but two years. It was built upon a six-inch concrete base, an inch and one-half sand cushion, with cement grout filler in the joints. A careful examination of the patches disclosed in every one taken up that in no instance had the filler penetrated more than one-half an inch. The remaining space was filled with sand or nothing.

It so happened that during the construction of this same pavement there had been some popular criticism of the brick on the grounds that they were underburned. To answer the criticism several samples were submitted to the standard rattler test. In every test made the brick averaged less than 22 per cent. loss, and were conceded by all interested to be of suitable quality. In fact, at the time of examination, the pavement showed little or no signs of wear, excluding the damaged patches.

Imperfections.

Other brick pavements inspected the following day, which were built by the same contractor, showed the same characteristic imperfections. On one of them, less than two years old, a workman was repairing one of these patches. He had taken out four rows of brick, beginning at the edging on either side and as far toward the centre as the middle third. A little over five feet of the pavement in the centre remained apparently intact. The brick taken out had the same appearance as all those in the other depressed areas. Upon being requested to do so, he struck the pavement two blows with a medium weight sledge in the centre of the intact portion. Immediately the pavement heaved perceptibly under foot, and the tops of the brick snapped off over an area of several square yards. The chips varied in size from two to three square inches to entire tops of brick one-half an inch deep.

Examination again showed that the grout had not penetrated more than one-half an inch. The day was a warm one, and the pavement had expanded. The load, instead of being distributed over thirty-four square inches, which would have been the case had the grout penetrated the entire depth, was concentrated on four and one-quarter square inches. Furthermore, the concentration was most disadvantageously situated for the brick to resist, namely, on the upper edge. The top edges of the brick were locked in a vise, and the impact of the sledge was enough to complete the destruction. This incident illustrates exactly what happened in all the patches. The effect of the sledge was identical to the impact of a heavily-loaded truck or other vehicle.

Unwashed Bricks Caused Trouble.

Another brick pavement in a different locality laid upon a four-inch concrete foundation, an inch and one-half sand cushion, with cement grout between the brick, not long after it was opened to traffic showed serious imperfections on one-half of the street, while the other remained in perfect condition. The street is now about five years old and the same relative condition has continued. Various explanations for the cause were advanced until one day the foreman for the contractor who had built the pavement but who had subsequently left this employer for another was asked for the real explanation. He replied thus: "I told the boss that would happen. All the brick stacked on that side of the street that looks bad were covered with clay and mud, and went into the street in that condition. Those on the good side were clean. I protested, and wanted the dirty brick washed, but the boss said, 'Hurry up; get them laid and grouted; we want to get out!' "

Still another brick pavement was laid on a street which bears a traffic of over 6,000 vehicles a day. It was put down in 1911, and the contractor's guarantee expired in the summer of 1916. Ninety per cent. of the pavement is in better condition to-day than when laid. The cement grout has been chipped out of the tops of the joints in the remaining 10 per cent., confined entirely to one end of the stretch of pavement. While the brick are not depressed, they are gradually becoming cobbled and spalled.

The appearance of the pavement was being discussed shortly after the guarantee expired, and it was then admitted by the contractor who did the work that water was scarce when his men grouted this portion, and that it was not sprinkled to wet the brick in the joints before the filler was applied. Therefore, the filler never bonded to the brick thoroughly, and later chipped out easily.

Adequate Specifications Not Enforced

Here have been described imperfections which in effect look much the same, but which arise from three different causes. No one of them is serious enough to make the pavements impassible, but they mar the appearance of the work and open the way for the ultimate failure of the several pavements through causes entirely foreign to the normal wear and tear of traffic.

To recall, the immediate cause of failure in the first instance was incompletely filled joints, in turn effected by a faultily-prepared sand cushion or defective grouting. The sand in the joints was the result of one of two things, perhaps both—that the cushion was not compacted enough in the first place or that the brick were over-rolled. In either case, the inspector should have discovered the sand-filled joints and ordered the brick removed, the cushion re-compacted, and the pavement relaid properly. The empty joints are explained by the fact that the grout bridged over probably because it was stiff and would not flow to the bottom. The writer was not able to find any lugs deficient in depth to prevent the free entrance of the filler; furthermore, it is known that the work was completed in December and was being hurried. Had the specifications for preparing the sand cushion and filling the joints been enforced these imperfections would not have developed.

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Again, the failure caused by the dirty brick was the outcome of a desire for speed on the part of the contractor and weakness on the part of the inspector in not requiring the brick to be washed. This, too, was a violation of the specifications. The same is true of the imperfection caused by failure to wet the faces of the brick in the joints before grouting.

The clauses in the specifications requiring that the sand cushion shall be thoroughly and uniformly compacted, that the grout shall penetrate to the bottom of the joints, that the brick shall be clean when laid, that the faces of the brick shall be wet before the filler is applied, are not impracticable. There is a good, sound reason back of each one, and at the same time each detail is most easily executed. These are merely representative examples of what has happened, and will continue to happen, as long as specifications which require them are not enforced.

Incomplete and Indefinitely-Phrased Specifications.

The foregoing typical instances arose in spite of adequate specifications which embodied provisions throughout in accordance with the best-known practice in brick pavement construction, and the responsibility therefore rests with those authorized to enforce the various provisions.

Sometimes it is necessary to go farther back to fix the responsibility for imperfections. Unfortunately, bids are constantly being received upon specifications which, if followed in detail, would not secure 100 per cent. construction. Either important elements are omitted entirely or so indefinitely phrased that satisfactory construction is entirely dependent upon the degree of good intent of the contractor. For the one who desires to slight his workmanship, to make speed at the sacrifice of thoroughness, the way is automatically opened.

For illustration, take specifications for the sand cushion. The consensus of opinion agrees that to be effective in a practical way the sand cushion must be thoroughly and uniformly compacted, and to secure this condition requires a very considerable degree of care and appreciation of the importance of doing it well. Compacting the sand cushion is not an operation to be slighted.

Yet what grounds would an engineer or inspector with the best intentions have for insisting upon a well-prepared cushion, in the face of disinclination on the part of the contractor, under the following specifications, which are in force at the present time:

"All (brick) pavements shall have a cushion of approved sand or crushed slag one and one-half (1½) inches in depth."

The same specifications devote over three and one-half pages to the quality and tests of brick. In the absence of a well-prepared cushion the highest degree of quality in the brick avails little in securing integrity in the pavement surface.

Lack of Specific Details.

An illustration from another source:

"A cushion of fine, clean sand, free from all impurities, shall be spread to a uniform depth of two (2) inches. The contractor shall then, by the use of proper templates and scrapers, grade the sand to a true and uniform curve or crown, as shown on the cross-section plan of the pavement, or as the engineer may direct."

Notice the absence of any specific provision for rolling the cushion, without which it cannot be compacted, to say nothing of being uniformly compacted.

One more example:

"On the foundation of concrete or broken stone shall be laid a layer of clean, sharp, well-screened sand, one inch in thickness when compacted, to serve as a bed for the brick. The sand shall be surfaced by a form to conform to the proper crown for laying the brick."

This clause gives evidence of a desire to secure the right kind of sand, but fails here or elsewhere in the specifications to state the exact proportions to which it shall be screened, except in the case of concrete sand. However, it does not necessarily follow that a satisfactory concrete sand is the one for the cushion. While it is specified that the cushion shall be compacted, it fails to say "how"—whether by hand or by roller, or to what degree.

Application of Grout Filler.

The application of the cement grout filler is a most important item of construction. It is essential that the grout shall penetrate to the bottom of the joints, and that it shall firmly bond to the faces of the brick. It must be so mixed and applied that if a 1:1½ mix is specified it shall so be in place. Most of the so-called separation in cement grout is not actually separation in the process of applying the filler, but failure to mix the cement, sand, and water thoroughly in the box. For this reason it is held that specifications should be full and precise on mixing as well as placing.

As an example of an indefinite and incomplete specification for grouting the following has been chosen for illustration:

"The pavement shall be filled with grout (and by grouting until they remain full to the surface), said grout to be made of one part of American Portland cement, which shall fulfill all the requirements of the specification, and one part of clean, sharp, and well-screened sand, with enough water added to make it a grout of the proper consistency. Sand and cement mixed dry, to actual measured proportions, and the grout thoroughly mixed in boxes, with hose or machine for that purpose. Brick shall be wet by sprinkling immediately before applying the grout. As soon as a section is completed, sand shall be cast over the surface, and the street shall be kept closed to traffic for four to five days."

The preparation of specifications—in other words, writing down what an engineer expects a contractor to do and how he shall do it—is at best a tedious job, but one worthy of the most exacting care and thought. A contractor may not be held legally or morally responsible to perform a single operation not set forth in the specifications.

In specifying how work shall be performed the use of such phrases as "in a skillful and workmanlike manner" or "to the satisfaction of the engineer" is provocative of unnecessary delay, dispute, and in many cases litigation. Under indefinitely worded and incomplete specifications is it reasonable to anticipate a high grade of workmanship? The answer and the remedy are both evident.

Criteria for Brick Quality.

In some instances pavements have suffered from soft brick, introduced mainly because they are of more perfect shapes than the usual overburned brick. In culling brick on the job the tendency is to conclude that the shapely one is more to be desired than one which is slightly distorted by overburning or the weight of other brick in the kiln bearing upon its surface. Greatly overburned brick are more apt to be brittle than tough and hard, but within reasonable limitations they may be used in the pavement, provided they are held securely in position. The limits of distortion have been quite carefully set in standard specifications for paving brick, and pavements have suffered little in this respect.

It is possible, also, to build brick pavements of soft brick, not as durable as those built of well-vitrified material, provided the details of construction are carefully watched. Such a pavement is illustrated by one section of the United States Government test road at Chevy Chase, Maryland. The brick in this one section tested 38 per cent. loss in the standard rattler. While the brick have worn somewhat, the surface of the pavement is smooth and even.

Uniformly vitrified and durable brick may be secured from reputable manufacturers, by reason of the fact that plant output is sorted on the bases previously mentioned before shipping or piling in the yard. Shipments other than as stated are not often made. Sometimes purchases are made by contractors without disclosing the purpose for which the brick are to be used, to obtain a lower price than that of first-class brick. Shipments of brick undoubtedly have been made in the past without due regard to uniform quality, but the practice has been so discouraged by the great majority of manufacturers that these cases have become extremely rare.

The American Society for Testing Materials has adopted standard procedure for the buyer and seller of paving brick in regard to acceptance and tests of brick, and the interests of the buyer have been well protected. If the methods of the society are followed there is no reason for any community to have inferior paving brick imposed upon it.

In spite of the value and scope of the work of the society, particularly in standardizing the rattler test, there are still some specifications for testing paving brick which read as follows:

> "Brick shall stand all such reasonable tests as to durability and fitness for the purpose as shall be required by the engineer."

As an example of the antiquated rattler test the following is presented:

> "Bricks will be placed in a rattler with 300 pounds of scrap iron, the pieces of which shall vary from one-fourth pound to five pounds; after an hour's revolving at the rate of fifteen revolutions per minute, the average loss in weight shall not exceed 9 per cent. on the brick."

In the first instance cited the matter of quality is left entirely to the engineer, in the absence of a definite advance understanding as to quality which should be the case in a transaction of this character.

The lack of merit in the second case of a rattler test such as this quoted needs no comment. A maker of paving brick which have a high reputation for quality recently refused to submit his brick for test under a similar specification. The chief point to be made with reference to this test is that under its vagaries a shipment of inferior brick stands nearly an equal chance of passing as one of quality. There can be no excuse for such tests remaining in force when certain standards which ensure a much higher quality and afford a real protection are readily available.

Old Foundations.

Not long ago a brick pavement was built upon a worn-out Telford macadam foundation. The old macadam was completely disintegrated and to a large extent the Telford base was exposed, but traffic continued to pass over the street, in spite of the jagged projections. As the first step in preparing the base the projections were knocked off in chunks, frequently five inches in maximum dimension, with heavy sledges. Immediately thereafter crushed slag, roughly between an inch and an inch and one-half in maximum size, was spread on the old base to depths ranging from three to eight inches, to raise the surface to a true grade and cross section. After having been slightly rolled, granulated slag was spread about two inches deep and the whole rolled again, but only lightly. Upon this was laid an inch and one-half sand cushion, upon which the brick were laid. The joints were filled with cement grout.

The street bears a heavy trucking and automobile traffic. The writer has observed Sunday traffic at the rate of fifteen hundred an hour, and during the week thousands of tons of building materials are drawn over the pavement into a rapidly growing portion of the city.

Less than a month after the pavement was opened to traffic a depression of about two square feet appeared. It grew rapidly in area, and some four months later the writer dug into the spot. In spite of the heavy pounding which had forced the loose brick downward, there were found nearly four inches of sand cushion and four inches of granulated slag before there were any signs of the slag foundation supposed to furnish the support.

About two square yards were indifferently repaired soon after this, but the spot has continued to grow until it is now nearly ten square yards in area. Incidentally there are several similar spots in the length of the street.

This and the other like failures may be directly traced to lack of uniformity in the foundation. In places the brick have received support; in others none at all. These defects are typical of what occurs in utilizing broken stone or old macadam foundations for brick pavements without exercising due care in workmanship when the foundation is consolidated.

Cracking.

The cause or causes of longitudinal cracking in brick pavements is a fruitful source for difference of opinion. It has been observed, however: (1) That they are most commonly found in regions of wet and heavy clay soil and extreme ranges of temperature; (2) that they open wider in wet weather than in dry; (3) that they decrease in width during the sunny hours of the day; (4) that they may or may not be accompanied by a crack in the artificial foundation if it be of concrete; and, finally (5) that in sandy or gravelly soils of easy natural drainage they are minimum in number.

Balancing the frequency of cracks in heavy clay soils with those in open, sandy soils, with or without extreme temperature ranges, the conclusion is logical that removal of water is an essential measure of prevention. Practically all sand cushions are wet when brick pavements are opened. The least resistance to expansion of a freezing cushion is upward through the brick surface, and this may account for a cracked surface, the base still remaining intact. When the base is also cracked, the upward movement presumably comes from the subgrade.

Cracking may also be caused in some measure by unequal bearing in the subgrade. Water seeping downward about the curbs will naturally work under the outside of the pavement and soften a portion of the subgrade. The loss in supporting power thus induced may be enough to allow the pavement to drop at the sides and open a crack at the centre.

Undoubtedly thorough artificial drainage in the absence of natural drainage will eliminate a very large proportion of the cracks.

Monolithic brick pavements have been remarkably free from longitudinal cracking. Thus far only one crack has come to the attention of the writer. Of course, all the troubles incident to faultily prepared sand cushions are eliminated. While monolithic construction is not presented as the panacea for all brick pavement troubles which arise in defective construction, nevertheless there is in it a large measure of protection against the great proportion of brick pavement imperfections.

Present Status of Physical Tests for Granite Blocks

By Clarence D. Pollock[*]

ALL tests which have been devised for granite intended for use in granite block pavements are more or less unsatisfactory except that of the service test. Until a very few years ago the test of actual service was the only one used for the purpose of determining the desirability of the different granites for paving. Then a number of cities began applying either the compression test or the toughness test, and some used both.

The American Society of Municipal Improvements, at its convention in Wilmington, Del., in October, 1913, inserted a clause in its standard specifications for granite blocks which read as follows: "The granite shall preferably be such as will give above 20,000 pounds per square inch crushing strength, combined with a uniform structure and toughness. The toughness shall be not less than 11, as determined by the method employed by the United States Department of Agriculture, Office of Public Roads."

A. S. M. I. Specifications.

At the convention in Boston in October, 1914, the above was changed to a minimum crushing strength of 20,000 pounds per square inch, and the toughness was reduced from 11 to 9. Then at the Dayton, Ohio, convention, in October, 1915, the crushing strength test for granite was omitted, because, in the words of the committee report, "it has been proven by many tests and by service that the crushing strength of a granite has very little bearing on its value as a pavement." The test for "French co-efficient of wear" was substituted for the crushing strength test as being nearer to the service conditions. The test requirements then read: "For heavy traffic the granite shall have a toughness of not less than nine (9) and a 'French co-efficient of wear' of not less than eleven (11). For medium traffic, the granite may have a toughness of not less than seven (7) and a 'French co-efficient of wear' of not less than eight (8) if a cement grout filler is used. The above tests shall be made by the methods described in Bulletin No. 44, United States Department of Agriculture, Office of Public Roads. The average of three (3) tests shall be used for determining toughness and the average of six (6) tests for determining the 'French co-efficient of wear.'" At the Newark, N.J., convention of the American Society of Municipal Improvements, October, 1916, these tests as adopted at Dayton the previous year were again adopted without change.

Uncertainty in Tests.

While these tests are far from perfect, yet they are the best now in use after the service test. Great care should be used in carrying out the details of these tests exactly as is done in the Office of Public Roads in the United States Department of Agriculture at Washington, D.C. For example, in getting the "French co-efficient of wear," if irregular pieces of granite, such as are obtained from a crusher, are taken, very different results will be obtained than if the pieces are gotten by breaking the stock to approximate cubes, as is done at Washington. Because of this lack of attention to details a great deal of trouble and expense is often caused, and it tends to discredit the test when one laboratory gives a sample a high rating and another gives the same granite a low one. Because of this uncertainty in tests many engineers do not specify any, but simply use blocks from quarries which have furnished good granite for paving purposes previously, as proven by the actual test of traffic.

At the present time various engineers are working along different lines in an endeavor to devise a test or tests which will more nearly approximate the actual traffic conditions, but in an accelerated form.

Crushing Strength Not a Satisfactory Guide.

The idea of using the crushing strength test evidently crept in from its use in selecting building stones. It has very little, if any, relation to the conditions to which the granite will be subjected after it has been incorporated in the pavement, and hence it is not a satisfactory index as to the desirability of various granites for paving blocks. There are many granites with a comparatively low crushing strength which have made most excellent pavements, when properly laid, and there are granites with very high crushing strength which have not proved suitable for paving purposes. A few engineers still hold to this test, but it has been pretty generally discarded.

The impact test for toughness seems to be nearer the actual condition in the street, but it is nevertheless far from being an ideal test. It is necessary that many more samples be subjected to this test and a careful study be made of the results before final judgment can be safely passed upon the merits of this test.

While the test for the "French co-efficient of wear" was originally intended to determine the availability of a granite or other stone for use in macadam pavements, yet many of the features which are desirable in a stone for macadam are also desired in granite for paving blocks. Altogether too few tests have been made as yet to prove conclusively just how valuable this test may be in selecting granite for paving blocks. A study of the small number of tests available in connection with the impact tests on the same granites rather indicates that these two tests, taken together, are an improvement in the right direction.

Traffic Conditions Must Be Approximated.

There is a good field for experimental work in this matter of tests of granite for paving blocks. The test should be one which causes an effect on the block or test piece as closely resembling the effect of actual traffic on the pavement as possible, but sufficiently intensive, so that ready measurement may be made of the effect after a short period. Until such a test is put in practical form, those engineers who do not require tests, but use granites from quarries which have proved satisfactory in the past, will continue to get as good, or better, pavements than those who specify numerous tests for the stone.

York County will spend $150,000 for good roads this year.

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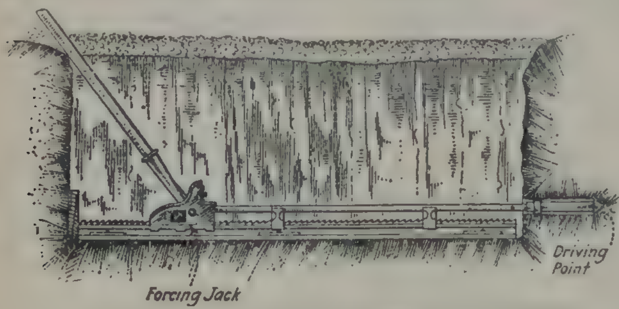
[*] Consulting Engineer, New York, N. Y.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Pipes Driven Under Pavements Without Trenching

Using the method shown in the drawing, a large Eastern electric service company has saved considerable trouble and expense in installing pipe conduits up to 4-in. diameter. The method, which avoids cutting through pavements and digging ditches which would obstruct traffic, consists in digging a pit at the side of the pavement, on the bottom of which the jack may be laid in a horizontal position. The cage on the jack, the front of which is provided with a groove and clamp, which can be adjusted to pipe ranging from ¾ in. to 4 in. diameter, is set at the far end of the rack. A short length of pipe is then inserted, to the front end of which is screwed, by means of an ordinary coupling, a steel nose. The jack is operated by a hand lever, forcing the pipe ahead into the ground. When the length of the rack has been traveled, the cage is carried back to the starting point and a new length of pipe inserted. The jack, similar in operation to an ordinary track jack, but with a much longer travel, is bolted to a plank when in use. The method was described in a recent issue of the Electrical World by C. L. Dalrymple.



Jack drives pipe up to 4 inches in diameter under pavement

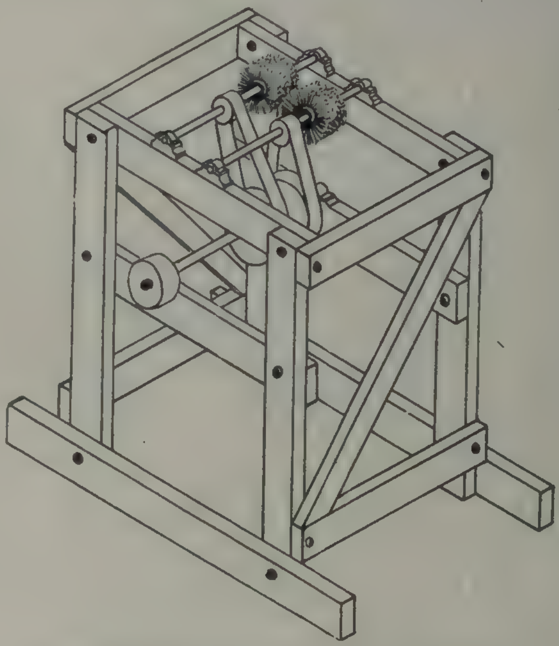
Brush Cleaner for Reinforcing Bars

Reinforcing bars covered with dust and mud are not the proper kind to use under any circumstances. Be the structure large or small, it is designed on an assumption of firm bond between the steel and the concrete. Anything which destroys this bond, as rust and dirt do, should be eliminated in the construction of the structure, in order that it may live up to the requirements which furnish the basis of its design.

The simple cleaner illustrated here, and reproduced from the Cement World, is built solidly out of short lengths of lumber such as are commonly considered scrap around the job. Two brushes are mounted on parallel shafts, and the power is delivered by means of belts from the countershaft in the centre of the frame. The drawing shows this countershaft extended outside the frame and fitted with a pulley. Power may be taken from the mixer engine or from some other source. In case electrical power is available, the skids under the frame may be extended and a motor mounted on them.

You contractors remember those little stunts you pulled off on your jobs last summer. You remember how proud you were of your clever little ideas that saved you a whole lot of time, labor and money. Perhaps you made a sketch or took a snap of your new kinks. It is just such things we are always on the look out for in this department. How about letting us have one or two, now that winter is here and work is slack and you have a little spare time? Jot them down roughly; we will fix them up. We'll pay you for your trouble, too.

Bearings should be protected by metal hoods, and if an electric motor is used it is advisable to house it in some sort of a sheet metal or wooden box, which will prevent sand and other such hard particles from lodging in the bearings. Reinforcing bars may be fed either way across the brushes, since there are no parts projecting far enough to interfere.



A cleaner that removes rust and dirt from reinforcing bars.

Cutting Battered Tops Off Sheet Piles

When driving steel sheet piles the tops in many cases becomes greatly battered. This causes trouble when attempting to pull them. Not only is pulling hard all the way up but the interlock of the pile being pulled is often so badly bent in drawing it through the battered section of the pile next to it as to make the pile useless. A method of remedying this is to use the oxy-acetylene outfit and make a straight cut all around the cofferdam taking off the battered tops of the piles. New pulling holes are burned in the piles and pulling can be very easily performed without damaging them.

Letter to the Editor

Philadelphia, Jan. 25, 1917.

Editor Contract Record:

The writer has read with considerable interest the article by Mr. T. L. Crossley on sheet asphalt street pavements in your issue of Jan. 17. With much that Mr. Crossley says those who have had long experience in the laying of asphalt pavements will heartily agree. With the very last sentence in his article, however, the writer positively disagrees. In this sentence Mr. Crossley says that with a medium close binder it should be quite safe to cut down the top thickness to ¾ inch.

Our experience does not indicate that such practice would be at all safe. On pavements like Fifth Avenue, New York, and the Thames Embankment, sections of which we have taken up from time to time, it is evident that the top does wear out by very slow abrasion. When removed, at the age of seventeen years, the Fifth Avenue pavement had worn down in places to a thickness of ¼ inch, and the wearing surface of the Thames Embankment pavement, in about ten years, has worn down from 1½ inch to ¾ inch. It can hardly be believed that had the top course of these pavements been originally laid at a thickness of only ¾ inch they would have shown the same wearing qualities, since it cannot be expected that a "medium close binder" will present the same resistance to traffic wear as is presented by a dense surface mixture.

Very truly yours,

D. T. Pierce,
Executive Assistant, Barber Asphalt Paving Co.

Steel Concern, with Changes in Management, Plans Future Development

Changes in the management of MacKinnon, Holmes & Co., Limited, of Sherbrooke, Que., have recently taken place, caused by the retirement from the company of Mr. A. R. Holmes, who in the past has occupied the position of director and secretary-treasurer. It is understood that Mr. J. W. Bowman, president, and Mr. G. D. MacKinnon, vice-president and general manager, have purchased the holdings of Mr. A. R. Holmes and his friends, and new directors, in the persons of Dr. A. W. Klein, of Greenwich, Conn., M. L. MacKinnon and J. Nicol, of Sherbrooke, Que., have been elected, with Mr. F. C. Johnston secretary-treasurer. The business will be conducted as in the past, under the management of Mr. G. D. MacKinnon, and it is understood the company is making extensive plans for future development. This company has been particularly successful in its general business of structural steel and steel plate work, having one of the most complete plants in the country for these special lines. It has also been successful in the forging of shells for the Imperial Munitions Board, having a very complete and up-to-date plant for this special work.

Mainly Constructional

East and West—From Coast to Coast

The Foundation Company, Limited, of Montreal, has been awarded a contract for constructing two test pits for the Canadian Steel Corporation, Limited, Ojibway, Ont. These pits will be each 90 feet deep.

There were 16 building permits issued in London, Ont. during the month of January this year at a value of $14,435. This compares with 9 permits in the corresponding month last year, valued at $19,230

Work on the $3,000,000 steel plant at Ashbridge's Bay, Toronto, has been started under the supervision of the Toronto Harbour Commission staff. The railway to carry in supplies has been completed, and bunk houses, storage sheds, etc., are now being erected.

The name of the firm of Heap and Partners, Limited, Montreal, has been changed to Samuel Osborne and Company. A factory has been secured on Seigneurs Street and equipped with machinery for manufacturing high speed tool steel. Mr. S. C. Buck is the superintendent.

Alexandra Park, opposite the General Hospital, Winnipeg, will be turned over to the Dominion Hospital Commission as the site on which to erect a two-storey temporary hospital of frame construction at a cost of $150,000, where wounded soldiers will be cared for.

The council of Peterboro, Ont., following the example of London, have decided to send a deputation to Toronto in March to urge that the government pay part of the cost of building the main thoroughfare in a town or city that would connect with the urban roads

Excavation work for the proposed incinerator at New Toronto, Ont., has been completed and arrangements have been made authorizing the corporation to lay water pipes across the Grand Trunk property to convey water to the site of the plant for construction purposes. It is expected that work will now advance quickly.

The new trunk sewer on the Lake Shore Road at New Toronto, which has blocked traffic for some time past, is now nearing completion. The work has been finished past the Mimico Asylum (stop 23). There are four blocks more to be finished, and then the Lake Shore Road will be free for traffic, until the Highway Commission starts work in the spring.

Plans have been deposited with the Public Works Department at Ottawa for works which are proposed to be carried out in the navigable waters of Burrard Inlet. The Canadian Robert Dollar Company, Limited, is putting in a wharf and sawmill on the north arm, and the Vancouver, Victoria & Eastern Railway and Navigation Company is putting in a wharf in Vancouver harbor.

Three million dollars has been granted by the Dominion Government for the erection of aviation school buildings and the carrying out of other necessary work in connection with the establishment of an aviation school sixty miles north of Toronto on a site some distance west of Camp Borden. The undertaking will entail the clearing of the ground, the construction of roads, and the erection of aviation sheds, hangars, machine and tool shops, office buildings, bunk houses, dining rooms, etc. The sewer and water system will be extended from Camp Borden. The school will accommodate five squadrons of 30 machines each

According to the opinion expressed by Mr. J. Hamilton Ferns, city assessor, of Montreal, active building operations are to be expected in outlying wards of that city during the coming summer. Mr. Ferns says: "The demand for houses is becoming much more brisk than has been the case for some time. It is surprising how dwellings are being sought in districts away from the heart of the city. More and more the business quarters are being utilized for the purposes of business only." Mr. Ferns adds that many property owners realize that even before the war ends there will be a rush to this country and the demand for dwellings may be phenomenal.

A civic deputation from Guelph, Ont., recently visited Toronto and interviewed the Minister of Public Works and the Deputy Minister of Highways with regard to the building of the roads adjacent to the city. The deputation pointed out that the financial condition of their city was such that they could not afford to assist in the construction of the roads leading into the city, as required by the legislation recently passed, and desired to be freed from this obligation, at least until such time as the roads inside the city were put in proper condition. The Minister of Public Works, however, did not see the matter in the same light and advised them to go back home and make the best arrangements possible with the county.

Application has been filed with the Toronto City Architect for the permit for the erection of the first unit of the big $15,000,000 departmental store to be built on the block bounded by Yonge, College, Terauley and Hayter Streets. The structure will be built, it is stated, with all-Canadian materials and with all-Canadian capital invested in it. It will be a 15-storey building and will rise 280 feet above ground and have a depth of 36 feet below it. Its cubic capacity will be 19,750,000 feet. The outer walls will be of brick and stone and the floors of terra-cotta. The 36 feet below the ground will be taken up by a basement and subbasement. Concrete will be used for the basement floors and foundation. Eight storeys will be erected at first, and later on, the other seven will be added.

On request of Mayor Montreuil, of Ford City, Ont., that municipality has been given permission by the Essex Border Utilities Commission to change the location of its proposed sewage disposal works from Sandwich Street, where it was the intention to install a screening process on the river front, and instead to make provision for an underground sedimentation tank on property south of the Grand Trunk tracks. Ford City is prepared to undertake this work as a temporary measure of relief. The extra cost is estimated at $4,500, which the town is ready to pay. This work will be independent of the general sewage treatment scheme for the metropolitan district, extending from Sandwich East to Sandwich West. The lateral sewers to be installed under the Ford City plan would serve for the joint scheme that is contemplated to serve the border municipalities.

The alterations and additions to the Post Office building in Quebec City, which have been under way since the spring of 1914, will be completed early next summer. Considerable excavation was involved in connection with the undertaking, these operations covering a period of fourteen months, during which time a steam drill was working steadily and the rock was blasted to a depth of 35 feet. This excavation was for the basement and foundation of the new building. When the renovations to the old portion of the building at the corner of Du Fort and Buade streets, have been completed, Quebec will have a very fine post office. The building will be fireproof throughout. The floors are of reinforced concrete overlaid with mosaic and the partitions are made of terra-cotta. All the pillars are of steel, set in concrete. There are over six hundred tons of steel in the framework. The height from the ground to the top of the flag pole on the dome is 200 feet.

Personals

Mr. William Forbes, of Woodstock, Ont., has been appointed superintendent of good roads in Oxford County.

Mr. J. E. C. Daoust, of the firm of Daoust & Gauthier, architects, has been elected president of the Montreal Chambre de Commerce.

Lieut. Percy Vere Binns, who is a graduate of the Faculty of Applied Science and Engineering of the University of Toronto, has been awarded the Military Cross.

Mr. J. G. Cameron, C.E., of Berwick, Ont., has been appointed as superintendent of the good roads scheme undertaken by the counties of Stormont, Dundas and Glengarry, Ont.

Mr. S. B. Bennett has resigned his position as municipal engineer of South Vancouver and will leave for England about the end of this month, having been appointed chemical engineer in a munition factory there.

Major Chas. Francis Hanington, M.Can.Soc.C.E., of the 257th Railroad Construction Corps, has left Ottawa for St. John, N.B., where he will endeavor to raise a company of 250 men and then proceed overseas.

Mr. George H. Duggan, past president of the Canadian Society of Civil Engineers, recently left on a business trip to England. He has been elected a director of the Wayagamack Pulp and Paper Company, Montreal.

Major V. L. Marsh, president of the well-known contracting firm of Marsh, Hutton, Powers Company, New Westminster, has been appointed commanding officer of the railway construction corps to be raised in New Westminster.

Lieut. C. S. L. Hertzberg, A. M. Can. Soc. C. E., of Toronto, who was recently awarded the Military Cross for bravery under fire, was wounded in the shoulder on January 31. He is a graduate of the Faculty of Applied Science and Engineering of the University of Toronto.

Mr. O. W. Meissner, M.E., has removed from Commissioners Street West to St. Antoine Street, Montreal. He represents a number of firms making railway, steel, and machinery supplies, is a special agent of the West Coast Pipe Company, Limited, Vancouver, patentee of the O. W. M. air track sander system, and president of the Steel Specialties for Canada, Limited.

Obituary

Mr. Robt. McBride, who for the past ten years has been road superintendent of the Province of British Columbia, passed away at his home in Vancouver recently. The late Mr. McBride was 58 years of age and came to British Columbia 28 years ago.

Mr. Lewis Francis Bonson, one of the survivors of the band of Royal Engineers who in the early days laid out the sites on which cities of British Columbia now flourish, passed away recently within a week of the death of his comrade-in-arms, Samuel Archer. Mr. Bonson was 85 years of age. He was born in Scotland and in 1854 joined the Royal Engineers. During his military career he served at the Crimea and for a short time was placed on garrison duty at Gibraltar, being later sent to Central America. Returning to England in 1858, he shortly afterwards sailed for British Columbia and came to New Westminster. After the engineers were discharged, Mr. Bonson went into the building business. From 1876 to 1880 he was provincial road superintendent, a position which his son, Mr. R. F. Bonson, held until recently. In 1892 he took up farming at Keatsey on the Fraser River, where he remained until he retired in 1905.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 February 14, 1917 No. 7

Principal Contents

Page
Editorial ... 133
Centre Street Bridge, Calgary, Alta. ... 135
Most Modern Construction and Equipment in Big Simpson Home for Girls ... 139
Drier Mixes Will Give Better Results ... 140
A Survey of Municipal Engineering ... 143
How Good Roads Affect Land Values ... 144
Stone and Concrete Foundations From the Standpoint of Efficiency and Economy ... 145
Tests on Asphalt Materials ... 146
Specifications for Concrete Floors ... 148
Practical Hints for the Contractor ... 150
Mainly Constructional ... 151

Less Water the Cure for Concrete Cancers

CONCRETE has been the subject of more extended and thorough investigation than, perhaps, any other modern structural material. The variability of its physical qualities, with its comparative novelty have made careful research of fundamental importance. Our knowledge of the properties of concrete and the mode of their variation is constantly undergoing change, and if the perfect concrete is to be attained, we must face an extension and a revision of the present information concerning the factors that go to compose it. Concrete, unlike its competitors in the structural field, is a composite material. Its properties are the balanced and resultant properties of three constituent bodies, each of which may differ in characteristics within an almost unlimited range. Hitherto investigations on concrete have, in the main, been limited to the study of cement and sand, and to the detailing of specifications covering their uniformity, gradation, and proportion of mixture, which, if adhered to, were supposed to ensure an ultimate result of the highest possible value. While these laborious studies were aiming at perfection in the finished product, the neglect of studying the third element—water—was invalidating results.

* * *

For some reason, little thought has been given to the function that water performs in concrete and to the effect that different quantities and qualities of water have on the strength of the concrete mixture. True, water forms but a small percentage of concrete, but small as it may be, it is not, by any means, insignificant. Cement and aggregate alone cannot, by any power, be made a coherent concretive mass, but add water, and, if the attendant conditions are right, the mixture will form a stone of the truest kind. Water, then, in both physical and chemical action, is the key substance of concrete.

The most scathing condemnation that is being made of concrete, as it is used to-day, is that it is made over-wet. Because water is cheap and also to save labor in mixing and compacting into forms, users of concrete are using an unreasonable excess. They subject their sand, stone and cement to the most rigid scrutinies, but they are neglecting the one factor that may or may not, according to circumstances, result in a perfect product. Concrete failures have served to show that an abuse of the water part of the mix oftentimes spells disaster. Many of the concrete cankers—laitance, day's work planes, incrustations, segregation—are set down, even in the mature mind, as necessary evils, and yet, though these cankers result in the greatest uncertainty of result, little attempt has been made to devise a remedy. Little investigation is needed, however, to correlate laitance, segregation and the rest, with an excess of water. Though excess water is, by no means, the cause of all defects, it is often important either as a first cause or in aggravating occurring deficiencies until they have an exaggerated influence in the final result.

* * *

So important are the principles here referred to, and to such a small degree are they recognized, that the article by Nathan C. Johnson in a contemporary journal and reproduced elsewhere in this issue, is of paramount value. The author discusses the subject of water in concrete from a practical standpoint. The warnings therein set forth are of the most timely interest, if concrete is to retain its prestige. The article contains what may be regarded by some as a ridiculous suggestion, and yet which, apparently, offers the only practicable solution to the laitance problem under present conditions of practice. Mr. Johnson recommends that, until laitance can be prevented by improved methods of manufacture, the lighter parts of the mix be wasted. This remedy is radical, but it offers food for thought and consideration by contractors who know only too well the difficulties they are contending with.

While discussing the problem of water proportion in concrete mixes, a closely allied matter appears to awaken discussion. Water serves its prime function in concrete by operating chemically, and concrete is a result obtained by chemical actions. Water is a substance varying within wide limits in chemical composition, as its solvent powers make its constitution uncertain. Water obtained in one locality will differ from that obtained in another, and since a uniform condition of purity is not demanded, it is reasonable to expect that the chemical actions promoted in the concrete mix will be affected. May not this also be a determining influence in the production of a perfect concrete?

Mobilization of Engineers Giving Complete Representation

SINCE the beginning of war, engineers and other technical men from various points in Canada have made repeated offers of their services to our government, but, for the most part, it does not appear that opportunities have arisen whereby such individual effort could be utilized. It is only within recent months, however, that technical men have made an effort collectively to assist in carrying on the business of the country during and after the war. The first effort of this sort found expression during the summer of 1916 in a report submitted to the Prime Minister of Canada by five members of the engineering profession. It was called a "Memorandum Regarding National Industrial Development in Canada," and outlined in considerable detail the necessity for a National Industrial Development Plan and the results desired through such a plan. The report suggested a method of procedure to obtain the necessary information and the formation of a permanent consulting board. This board was to be composed of two representatives each from civil engineering, mechanical and electrical engineering, mining and metallurgical engineering and chemical engineering societies, who would appoint a well paid and highly competent engineering secretary.

We believe the report is most admirable in practically every detail and in the absence of amendment and improvement should be adpoted without delay. One or two main objections, however, do suggest themselves, which briefly may be stated as: (1) that a very large number of Canadian technical men are not represented by any of the societies named, and (2) that the almost certain tendency would be to localize the representatives of these four organizations. The success of any such scheme, however, must depend very largely on the careful attention paid to these very factors, i.e., **all** technical men in Canada must get behind the scheme, and **all** provinces must stand—so far as is compatible with effective operation—on an equal footing. How can this be accomplished?

It may be too early to pass a definite opinion, but it is suggested that the solution lies in the utilization of a type of organization that quite recently found expression in the Province of Ontario and has already spread with great rapidity and enthusiasm to four or five other provinces. The underlying idea of the new organization, which is called into being primarily for war purposes, is that all the technical men in each province shall be banded together, for more effective work, into one powerful local organization. In Ontario, for instance, each of ten engineering and technical organizations have elected one member to a "Joint Committee of Technical Organizations," who in turn have elected a small working Executive Committee. We understand the other provinces are organizing along very similar lines.

The suggested improvement to the report outlined in our first paragraph follows naturally, we believe, from the formation of this group of Joint Committees. It is simply this: Let the Joint Committee of each province, instead of each society, name representatives to the Consulting Board. Here we have every province represented. Here also we have every technical organization represented. The plan is quite as simple as that outlined in the report, and, we submit, is much more comprehensive, would have the backing of practically twice as many technical men, and therefore would be just so much more fruitful in results.

A View of Necessary Action for After-the-War Conditions

"A VIEW of Necessary Action for After-the-War Conditions" was the subject of an address by T. R. Deacon, C.E., ex-Mayor of Winnipeg, president of the Manitoba Bridge and Iron Works, delivered before the regular February meeting of the Manitoba branch of the Canadian Society of Civil Engineers. Mr. Deacon pointed out the necessity for action to meet the conditions in Canada arising from the present war. He believed that in the solving of a great number of problems and in carrying out the industrial work after the war the engineers would have a very considerable part. That there would be a large demand for engineers would be due to the work which of necessity must be carried forward to utilize the energy represented by the 400,000 men now in the army and 80,000 to 100,000 men engaged in munitions and kindred work.

In brief, the problems Canada must face at the close of the war are:

1. Payment on a national debt, which will probably amount to $5,000,000,000.

2. An annual pension fund.

3. The utilization of some 80,000 to 100,000 men at present engaged on munitions and kindred employment, who will be immediately thrown out of work on the cessation of hostilities.

4. The return of some 400,000 men from the front, comprising some of the best blood and energy of the country.

If these 500,000 men engaged in the war or in industries arising from the war are to be retained in the country and given work in order to prevent their immigration to the United States, a comprehensive programme should be undertaken by the government of the country. That the work must be of a manufacuring or an industrial nature did not require proof, as it would require the wildest stretch of imagination to believe that these men will turn to pioneer farm work when manufacturing and industrial work was available south of the Canadian boundary.

In place of allowing the raw product of the soil, forest, fishery, and mines to be exported from the country, Mr. Deacon believed that it is not only practicable but assuredly possible to provide industrial work which would utilize these raw materials, and which, in turn, would not only utilize the energy of these 500,000 men, but would also help materially towards reducing and meeting the payment on the national debt.

The most feasible method of utilizing each of the natural resources appeared to him to be by copying the German plan of state co-operation with the manufacturers. That there would be many difficulties and many obstacles in the working out of such a scheme he admitted, but believed it was the most practicable method of meeting the conditions which would arise after the present war.

Centre Street Bridge, Calgary, Alberta

Notable Reinforced Concrete Structure, Costing $400,000, Designed to Meet Peculiar Conditions—Methods Planned for Economy—Monumental and Utilitarian

By Geo. W. Craig and John F. Greene*

The Centre Street Bridge improvement in Calgary, Alberta, consists of three parts: 1st, the bridge proper and its south approach with a total length of 1,300 feet; 2nd, a fill and cut extending 2,100 feet north from the bridge; 3rd, a side hill cut, forming a road which meets Centre Street at the face of the hill, extending west for 2,800 feet (of which 2,300 feet is in cut). The south end of the bridge lies five blocks from the business centre of the city.

The improvement provides a convenient avenue for traffic between two parts of the city; the residential section lying north of the river, and the business portion which stands on the former flood plain on the south side of the river. The roadway has a maximum grade of 3.85 per cent. with a minimum width of 42 feet on the bridge, and provides for two lines of street car traffic, and contains two sidewalks each 7 feet wide.

A low level roadway 18 feet wide, slung from the bridge deck, provides for highway traffic to a residential section lying on the flood plain north of the river below the bluff which commands the city, while the side hill cut provides a means of communication between the low and hill levels north and west of the bridge.

Design Problems

The Bow River, which passes the bridge at an angle of 60 degrees with the centre line, has a flood volume of about 55,000 second feet, and is about 500 feet wide at the bridge site. The problem from the viewpoint of the designer may be stated as follows: Given a height of 29 feet from the water line to grade at the south bank, 47 feet, or 18 feet more, at the north bank, with a skew of 60 degrees, to obtain a structure which shall provide for all probable traffic requirements on a high and low level during its life, and at the same time present an appearance in keeping with the dignity which should characterize public works of a monumental character, and this for a predetermined amount of money. The designers were impressed with the importance of lending to the structure the grace of proportion and of suitable ornament. The irregularities of grade and skew contributed much to the complexity of the problem, and it was only after numerous trial elevations, based upon radically different conceptions, that a final arrangement was arrived at that seemed satisfactory. It was considered necessary to incur the expense of constructing a wooden model of a portion of the bridge to be assured that the treatment would produce the desired effect.

Loading

The various parts of the bridge were designed for the following live loads:

Floor—Concentrated loads—
    Car beams and slab—50-ton cars on both tracks.
    Road beams and slabs—20-ton motor trucks.
  Uniform loads—
    Road—100 pounds per square foot.
    Sidewalk—100 pounds per square foot on outside four feet.
    Sidewalk—40 pounds per square foot on remainder.
Low level—Concentrated load—20-ton motor truck.
  Horizontal load—300 pound per lin. ft. of structure.
Arches—Concentrated loads—four 50-ton cars per 150-foot span, with uniform loads on roadway and sidewalk, same as for the floor.
  Temperature—rise of 50 degs. and fall of 70 degs.
Maximum stresses—
  Concrete—Floor—Compression 530 pounds per square inch.
  Arches—Maximum compression—
    (Live load and dead load), 540 pounds per sq. in.
    Rib shortening, 677 pounds per square inch.
    Maximum tension full load with 70 degs. fall of temperature, 30 pounds per square inch.
  Steel—Maximum tension per square inch, 16,000 lbs.
  Foundations—Maximum pressure upon rock, 12,300 pound per square foot.

Deep Narrow Ribs Economical on Concrete

Owing to the high cost of concrete materials, and to the depth of the piers and abutments, it was economical to use deep narrow ribs, in obtaining the required carrying capacity in the arches. Assuming a crown thickness of 5 feet and placing the springing line of the flattest arch at low water level, it was found that there would be required 2 inner ribs, each 6 feet wide, and 2 outer ribs, each 4 feet wide.

On the second arch, retaining the same crown thickness and the same distance below the floor for the extrados at the crown, it was possible by taking advantage of the grade and increasing the rise of the arch, to reduce the width of the ribs, using 2 inner ribs at 5 feet instead of 6, and 2 outer ribs at 3 feet 3 inches instead of 4 feet. At the same time by raising the springing line of the arch, the moment arm of the thrust from the higher and narrower ribs was increased about the pier base, enough to offset the moment of the greater thrust from the lower and wider ribs. Again, on the third span, by increasing the rise it was possible to use ribs 4 feet wide and 2 feet 6 inches thick instead of 6 feet and 4 feet as on the shallowest span.

Cellular Type Piers

The piers are of the cellular type, the supports for the arch ribs resting on a concrete pedestal 5 feet thick, extending over the entire area within the cofferdam. These supports for the arches are connected by reinforced core walls 2 feet thick, those between inner ribs constituting supports for the low level deck, and those between inner and outer ribs rising to the upper deck, the whole pier presenting the appearance of two solid shafts. Manhole slabs have been provided in all piers and abutments, for the convenience of the power, gas and telephone companies which have service mains on the bridge.

The retaining wall at the north end of the bridge is 48 feet from base to top. The upper 12 feet of the wall is of the cantilever slab type, the lower portion consisting of counterforts and slabs. The reaction from the cantilever slab portion is carried by the adjoining three feet of slab to adjacent counterforts, extra steel having been provided to carry this load.

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* Read Before Canadian Society of Civil Engineers

The retaining wall at the south end has an umbrella shaped top, the four-inch sidewalk slab projecting several feet on both sides of the wall. Expansion joints have been provided at regular intervals in the wall, with lead strips 10 inches wide to prevent seepage through the joints.

Provision for Expansion

The problem of expansion joints for the floor was an unusual one, owing to the peculiar conditions. The spandrel ribs were designed as T beams, with the floor slab for the flanges of the T. All floor beams are perpendicular to the centre line of the bridge, while the piers and abutments are skewed. On each pier and abutment there was provided a heavy expansion beam upon which the system rested. Assuming the slabs over the box piers as fixed, the slabs on the arch spans moved to or from the expansion beam. Beams resting upon pier walls moved on steel plates, in open pockets; slabs over piers rested only on the beams, a layer of clay one inch thick interposing between the wall and the bottom of the slab. Joints over the arch spans were made in the slab midway between beams, the slabs in these expansion panels having been designed as cantilevers. Troughs covered with lead were provided at all expansion joints, these troughs draining into pipes provided in the piers.

Passing from the utilitarian to the aesthetic aspect of the design, one must bear in mind that the treatment of the parapet, piers and abutments should please and impress favorably both the distant observer, who will view the structure in toto, and also the more frequent observer, who will view it from the sidewalk or from the passing automobile.

For the close ranged observer we have provided four ornamental kiosks, and a massive concrete parapet of premoulded concrete balusters, base and rail. The kiosks span the sidewalk and open on observation balconies cantilevered from the side walls. The east and west faces expose shields containing the emblems of the various parts of the British Empire, the maple leaf for Canada, the rose for England, the shamrock for Ireland and the thistle for Scotland. Above the north and south faces and over the walks are buffalo heads, emblematic of Western Canada; the whole forming a pedestal of a massive British lion, 13 feet long by 7 feet high. The ensemble is symbolic of the permanence and stability of the British Empire supported by its component parts.

Architectural Features

The piers are surmounted by slotted battlements treated with steel grill work. The plan of the pier parapet is a half hexagon. Inasmuch as the skew of the bridge is 60 degrees, an angle of the hexagon forms a nose or cut water at the upstream face of the pier, while at the same time presenting a symmetrical deviation to the passing observer.

The illumination of the bridge will be effected through the agency of fluted cast iron standards on the piers, and four torch bracket lights on each kiosk. All iron work will be painted a gray color which will nearly match the concrete.

For the distant observer viewing the bridge as a whole an attempt has been made to break up the dull flat surfaces which from their extent and from the sameness of color impress one unfavorably. Working from the hypothesis that it is neither expedient nor economical to eliminate board marks from concrete faces, we have adopted the policy of substituting grooves and pilasters which will serve both to withdraw the eye from the necessary minor irregularities of the concrete surfaces, to break up the surfaces and to heighten the effects aimed at, whether of depth by the use of vertical lines or of breadth by the use of horizontal lines. The faces of the piers have been panelled and grooved; the faces of abutments have been pilastered and the form sheeting has been run up and down to convey an impression of greater height. The arch rings were grooved at regular intervals, serving the double purpose of breaking up the rib face, and of offering suitable location for construction bulk heads. The face of the north retaining wall was broken up by horizontal grooves and by battered pilasters, marking the locations of the counterforts on the back of the wall, and carried up above the rake of the wall, breaking the skyline.

The 62-foot arch spanning the boulevard on the north side of the river supported deep spandrel walls, the faces of which were marked with pilasters, and the arch was crowned with a large date stone and a seal of the city of Calgary 6 feet high by 4 feet wide.

The Low Level Bridge

The low level structure, with a roadway 18 feet wide, consists of a structural steel frame, with a concrete floor slab, and an asphaltic concrete wearing surface. It is suspended by hangers, each consisting of two steel angles engaging a pin and linked to steel bars with an eye on one end and a thread upon the other. The threaded end passes through a yoke consisting of two 7-inch channels with top and bottom cover plates. These yokes are embedded in the main floor beams with the bottom of the yoke 18 inches from the bottom of the beam.

The concrete slabs for the low level consisted of premoulded blocks suitably reinforced, 4 feet by 3 feet 8 inches; each slab was a double T with flanges 3 inches thick, and the stems projecting 4 inches below the slab. These blocks rest on the top flanges of the steel I-beam stringers. This unusual type of slab was adopted for two reasons: 1st, to reduce the dead load weight of the structure; 2nd, to permit of the completion of the erection in the dead of winter with a temperature at zero or less.

From the standpoint of economics with cement at $2.40 a barrel and structural steel at $80 a ton, the adopted design cost 40c per square foot, against 58c per square foot for the standard design, with a 6-inch slab and I-beam stringers.

The spandrel arches were designed as beams continuous over three spans, all moments and shears being worked out for concentrated loads by means of the three moment equation. Expansion joints have been provided in these spandrel walls, layers of three-ply roofing intervening between adjacent parts. Joints at the one-third points in the arch spans allow for the opening due to the rise of the arch with a rise in temperature and joints at the piers and abutments provide for the fall of the arch with a drop in temperature, and the consequent drawing away of the spandrel walls from the piers.

Depth for Minimum Cost

Economic depths of beams and slabs as determined by the local costs of cement, sand, gravel, lumber and steel have been ascertained by the well-known principles of maxima and minima of differential calculus, the process entailing the writing of an equation for the cost of the material for the beams in terms of money and depth, and solving for the depth which will make the cost a minimum.

The concrete for the arches, beams, slabs and retaining walls was prepared in the proportion of one part of cement, two of sand and four of gravel; the foundations and all pier and abutment walls 1:2.5:5; the handrail 1 of cement to 2.5 of sand.

The cement was purchased upon the specifications of the Canadian Society of Civil Engineers, with the exception of the tensile strength requirements for one to three mortar; these were raised from 150 to 200 pounds per square inch for 7 days, and from 225 to 275 pounds per square inch for 28 days. The product of the Canada Cement Company met this requirement.

A washed, screened sand was required according to the specification with grading clauses, rejecting sand with more than 40 per cent. by weight passing a No. 30 screen, or more than 3 per cent. passing a No. 100 screen. The gravel washed and screened was purchased upon a void specification, the maximum not to exceed 40 per cent. The maximum diameter of particles for use in piers, arches and walls was approximately 5 inches, this limitation being due to the efficiency of the mixing machine, not to probable diminution in the strength of the resulting aggregate. In the floor system, owing to the intricate network of steel, it was necessary to limit the maximum diameter to 2 inches. Whenever expedient, as in piers and abutments, boulders were embedded in the concrete.

Active construction work upon the bridge began in April, 1915, in June the Bow River was flooded, reaching a peak on the 26th, the highest since 1897. On this day the temporary bridge used as a traffic way during the construction of the bridge was washed out. Mr. Craig and City Commissioner Garden were on the structure at the time. The former made his way to shore by climbing a panel of the deck, one end of which was in the water. Mr. Garden was swept downstream, but was pursued by two of the bridge men who had put off after him in a boat provided for such an emergency. They succeeded in landing him on an island about a mile downstream.

Foundation Conditions

Soundings at the piers disclosed the following substrata. In pier No. 1—gravel and large boulders 5 feet, clay 3 feet, soft shale 4 feet, sandstone 4 feet, clay 3 feet, hard shale 15 feet to limit of drilling. In pier No. 2—gravel and large boulders 5 feet, clay 2 feet, sandstone 4 feet, soft shale 5 feet, sandstone 5 feet, hard shale for 15 feet to limit of drilling.

Experience with the river upon other bridge foundations taught that it was necessary to guard especially against a possible great scour. Shifting gravel bars situated both above and below the bridge tend to restrict the flow to certain channels, and in times of flood, with attendant high velocities, there is a considerable scour in these channels. Hence to provide adequate protection against scour, the excavation was carried through the bottom layer of sandstone and well into the hard shale rock beneath. The shale rock was of such quality that there could be no question of exceeding the allowable bearing power.

The cofferdam consisted of two layers of Wakefield sheet piling, with an 8-foot puddle. The sheet piling was driven to refusal in the gravel; centrifugal pumps were installed; the dam pumped dry; excavation commenced on the general plan of removing the material under the sheet piling first, driving the latter home and then removing the material in the middle. When the sheet piling had penetrated the clay underlying the gravel, a layer of 3-inch plank was driven approximately to the sandstone level. The material was broken up by blasting and removed in skips by a derrick. There was considerable leakage from the gravel and boulders, the water rising between the sheet piles and the planking; and at the beginning it was necessary to operate four centrifugal pumps to keep the water down to a working level. After penetrating the clay one could hold the water ordinarily with one pump.

In the construction of pier 2 work was discontinued in the middle of January after a cold spell in which the temperature had dropped to 46 below zero. The excavation was still in the gravel.

Mishaps in Cofferdam

Upon recommencing work late in March it was found that the ice had so disrupted the cofferdam that it was impossible to lower the water to a working level. The puddle was frozen solid, and the ice inside the cofferdam was approximately four feet thick. The choice of action lay between digging out the entire puddle, replacing it with a new one, or digging out only such portion as was necessary to stop the worst leaks. Proceeding on the assumption that it was cheaper to risk a few blow-outs than to remove and replace the puddle, we adopted the latter method, and completed the excavation after various mishaps, including three minor and one major blow-outs, the latter flooding the hole so quickly that there was not sufficient time to accomplish the removal of the four pumps which were below water level; one of these with its motor was flooded. We found that after plugging a blow-out the dam would hold tight for about 72 hours; the jar resulting from the operation of the steam drill and from the blasting, together with the gradual melting and disintegration of the frozen puddle, would start new leaks, which quickly attained sufficient proportions to require attention. The pumps, all centrifugals, were operated with check valves on the exhaust pipes, under an average suction lift of 19 feet and a maximum of 23 feet. The pier work was a continuous operation carried out in three shifts daily of eight hours each. Work upon this pier began on March 23rd and the concreting of the pier had begun on April 14th. It was evident that in order to prepare the bridge ready for traffic in 1916 it would be necessary to complete the concreting of two of the river arches before high water, thereby permitting the completion of the superstructure of most of the bridge before the subsidence of the water. A conservative estimate of the earliest probable date of the flood, made after an examination of the records of the Irrigation Department and after conferences with those most familiar with the local river conditions, placed it as June 1st.

The work was so conducted by the employment of double shifts of carpenters working from dawn to dark, that the concreting of the key of the second arch had been completed on May 19th. The removal of falsework on this span began after four weeks on June 13th. On June 19th, when all the false work above the pile caps had been removed, the flood came, reaching an elevation within a foot of the record flood of 1915, and washing out five bents of piles in arch No. 3.

Concreting Methods

Each pair of ribs in an arch span was concreted in eight sections, four on each side of the crown, beginning with a section at the crown, to prevent a rise of the falsework in the middle, and then working up from the haunches. This method of concreting in small sections not only reduced the initial stresses due to contraction of the concrete to hardening, but also lessened the excessive load due to the 60 degrees skew of the piers upon the forms on the low side of the arch ribs. This load was so great that it was found upon trial inexpedient to use No. 6 wire, and necessary to resort to ⅜-inch rods spaced about three feet centres, to hold the side forms.

All concrete both in the arches and in the deck was transported from a mixing plant located at the north shore in hand-pushed buggies, run on temporary runways. As a matter of economics the cost of placing concrete in the arches, including charges for plant and shop, was $1.02 per yard.

The design of the bridge was such that a high speed plant for conveying concrete was inexpedient and uneconomical. With a total length of approximately 1,000 feet and a yardage above ground of 7,000 yards, the cost of distribution per yard by a system of towers and chutes would have exceeded that of the method adopted. The construction of an economically designed reinforced concrete bridge proceeds in a series of well-defined steps; the concreting of sections of the arch rings, the spandrel columns, the spandrel arches, and the floor, run in sections from expansion joint. The maximum run for a day was 173 yards, the average daily run about 60 yards.

Chuting Impairs Quality

The allowable stresses, assumed for the design, presupposed an excellent grade of concrete. Such a concrete may be obtained after a proper proportioning and mixing, only by a careful supervision of the final disposition of the material, after release from the conveyor. Proceeding upon the assumption that the concrete shall contain the least quantity of water consistent with the quality of being "alive," that mortar pockets and rock pockets are points of weakness, that no vehicle will deposit concrete in forms in a proper condition, it followed necessarily that every batch of concrete deposited in its final resting place required testing and handling to insure the quality desired. Previous experience with the chuting system on bridge work disclosed the existence of two great attendant evils: the temptation to grease the chute with an excessive amount of water, and the tendency to operate the mixing and conveying portion of the plant at maximum capacity, regardless of the ability of the placing crew to handle the material properly. By a judicious combination of both evils the material may be placed at a minimum of expense, but the resulting aggregate may have a compressive strength of less than half that of a properly handled concrete. In conveying the concrete by the push buggy method, the incentive for sweetening it with water is removed and the material of a proper consistency is deposited in small batches at regular intervals in such a manner that the final handling is facilitated greatly.

The concrete handrail, consisting of a top and bottom rail with a turned baluster, was made by the dry process. The bottom rail was moulded in place; the top rail was cast upon the sidewalk adjoining its panel; the balusters were made in the construction yard, and the posts were cast in place after the assembling of the above mentioned precast parts. The best production record in making balusters with two men working with one cast iron mould was 65 balusters in 11 hours.

The ornamental work consisting of the panel 6 feet by 4 feet containing the seal of the city of Calgary, the small shields on the kiosks, and the lions, were made by the dry process. A full-sized model of the lion 13 feet long by 6 feet wide by 7 feet high was done in clay; a plaster cast, consisting of a shell about an inch thick and containing over 400 pieces, was fitted over this model, and a heavy 4-inch coat of plaster forming large supports for the smaller pieces of the inner coat of plaster, was cast upon the outside. The lions were then cast each in five pieces. All artistic work in connection with the modelling and making of plaster casts was done by J. L. Thompson, of Calgary.

Cut and Fill

The second portion of the improvement, consisting of a cut and fill extending north from the bridge 2,100 feet, was started in the fall of 1914. The first cut was made with an outfit consisting of two elevating graders with teams and wagons. The work was difficult and expensive in that it was necessary to build up a dump at the edge of a steep cliff.

During the following summer a 60-ton "Marion" shovel was installed in the cut; the loaded dump cars were lowered down on the dump, controlled from a steam hoist set at the north end of the cut. The building of the dump accomplished without the aid of a construction trestle, the raising of the tracks going on simultaneously with the building of the dump. Work was discontinued in the fall of 1915; the Centre Street cut and the side hill cut 2,800 feet long were completed during 1916. The total yardage of earth moved was approximately 220,000.

The total cost of the improvement, including $34,000 for condemnation and right-of-way, was $400,000.

The improvement was conducted under the direction of George W. Craig, City Engineer, with John F. Greene as Bridge Engineer in charge of the design and the construction of the bridge. They were assisted in the design by Frank Lawson, Lieutenant, 56th Canadian Overseas Contingent, who was killed at St. Eloi in April, 1916, and by J. Bernard Richards.

The construction work was done under the day labor method with James Patterson as construction superintendent. The earth work north of the bridge and a portion of the foundation was carried on under C. M. Arnold as Resident Engineer in 1915, and the balance of the grading work was carried on under C. LeB. Miles in 1916.

Fire Testing Apparatus

The apparatus installed by the United States Bureau of Standards for testing the resistance of structures and materials to fire, as mentioned in the Contract Record of Jan. 3, is housed in a steel frame building, the materials to be tested being built within heavy steel frames. A furnace, with an open face, measuring 16 feet by 20 feet, and burning fuel oil blown in by a steam jet, supplies the various temperatures, which are measured by suitable apparatus. The frame containing the panel to be tested is swung by means of a crane in front of the furnace. The heat is then accelerated, and, after a definite length of time, the panel is drawn away, and, while it is still hot, a stream of water is played upon it—providing, of course, there is anything left of it after the fire test—under 80-pound pressure, through a 1⅛-inch nozzle.

The American Concrete Pipe Association are holding their annual convention in Chicago on February 12-14.

Completed Simpson Home and Club for girls, showing old residence in the centre.

Most Modern Construction and Equipment in Big Simpson Home for Girls

THE photographs reproduced herewith illustrate the new building erected by the Robert Simpson Company as a home for women and girls employed by that company in Toronto. It is known as the Sherbourne Street Club, and at present has sufficient accommodation for 150 girls. The building is of modern construction, fireproof throughout, and while no very unusual methods were employed in its erection, it yet involved many features of interest to the contractor. It is a three-storey and basement structure and is 300 feet long. The main portion is 36 feet deep, while at each end of the building there is a wing which extends 12 feet on the western side, giving these portions a depth of 48 feet. The main section is 204 feet in length, and the two wings are each 42 feet wide. The three upper storeys are 10 ft. 3 in. in height, while the basement is 12 ft. 6 in. The new building is located immediately to the rear of the old home of the late Senator George A. Cox, and is connected with it by a short corridor.

Form work for the floors. A reinforced concrete joist type is used.

Fireproof materials have been used exclusively in the construction of the building. The foundations are of concrete, as are also the basement walls and floor, and the walls are of solid brick masonry. The three upper floors are of the reinforced concrete joist type, and the roof is of similar construction. Fire escapes have been provided at each end of the building and within the house there are three fireproof stairways. One of these stairways is in the centre portion of the building and the other two are placed, one at each end, enclosed within fireproof walls. They are of steel construction, with concrete treads. Provision has been made for one elevator, and a dumb waiter has been installed.

Concrete Joist Floors.

The three upper floors of the structure, of concrete joist construction, were each poured in two sections. Each of the two sections is supported on one side by the brick-bearing wall of the building and on the other by a reinforced concrete beam, 12 in. wide by 24 in. in depth, which runs the entire length of the structure. This beam is supported by reinforced concrete columns, spaced at 19 ft. 10 in. centres. The span from

Exterior during erection

the beam to the wall on one side is 16 ft. 2 in. and on the other side is 19 ft. 10 in.

The floors were poured on wooden forms. In the case of the narrower section of the floor, 16 ft. 2 in. wide, forms 5½ in. deep were used, in which reinforcing was placed and concrete poured to form the joists. The concrete was then poured to a depth of 2½ in. over the joists and tops of the forms, making the total thickness of the floor at the joists 8 in., and leaving a depth of 2½ in. of concrete over the hollow sections of the floor. The joists are 6 in. wide at the top and 5 in. wide at the bottom, and are spaced at 24 in. centres. In the case of the wider section of the floor, covering the distance of 19 ft. 10 in. between the supporting concrete beam and the wall, the wooden forms were 7 in. deep, in order to carry the extra dead load. One of the illustrations shows the building in course of construction and work progressing on the third floor. The forms used for the pouring of the concrete floor may be seen. The concrete columns supporting the first floor are 20 in. square. On each succeeding floor they decrease in size, being 18 in., 15 in., and 12 in. on the first, second, and third floors respectively. The brick walls are 14 in. thick. The exterior finish is of Oriental brick, with raked joints, ½ in. wide.

The basement of the building, which is well lighted with full-size windows, contains the kitchen, laundry, and the dining-room. Terrazzo flooring has been used in the kitchen and laundry, while the dining-room is floored with oak. The most modern equipment required in a building of this nature has been installed. In the kitchen the most up-to-date fittings in the way of dish-washers, refrigerators, steam tables, carving tables, urn stands, etc., have been provided, all such equipment being heated by steam where necessary. The laundry is equipped with washing machines, extractors, tumblers, etc., all electrically operated. A laundry room has also been provided with six individual tubs and individual ironing boards, where the girls may do their own washing. The other floors are devoted to rooming accommodation for the girls. The roof of the building is furnished as a roof garden.

Future Extension Provided For.

It is the intention at a late date to extend the wings of the structure toward Sherbourne Street, thus forming a three-sided building. The rooming accommodation of the club is at present 150, but in the kitchen and dining-room provision has been made for 300 girls, so that these will be of sufficient capacity when additions are made at a later date. The old Cox house, on Sherbourne Street, is now devoted exclusively to club purposes.

The building is heated by steam, with direct radiation. Fess oil-burning boilers, supplied by the Gurney Foundry Company, have been installed for this purpose. The brick used was supplied by the Don Valley Brick Company. The Rogers Supply Company supplied the sand, gravel, and cement, and the Burlington Steel Company the reinforcing steel. Gum wood for the interior finish of the home was obtained from the Laidlaw Lumber Company. Purdy, Mansell, Ltd., carried out the heating and plumbing work.

The building was designed by Max Dunning, of Chicago, and the general contract carried out by the Wells Brothers Company of Canada, Ltd.

Drier Mixes Will Give Better Results

Many of the Deficiencies of Concrete Can be Traced to Excess Water—Radical Suggestion to Eliminate Laitance Trouble

No structural material has become so popular within recent years as concrete. The field of its application has been constantly extending and it has been called upon to perform greater services and to serve new functions. In many lines it has practically superseded other materials. This popularity is no doubt accounted for by the ease with which the material is fabricated and moulded; it adapts itself more readily than any other structural body to widely varying requirements. Concrete is a composite body and on this account its manufacture is not subject to the same constancy as the more homogeneous and uniform materials. The very fact that concrete may be of such variable composition demands careful and rigid inspection to ensure a product capable of withstanding without failure the demands with which it is called upon to cope. Closer study is all the more required in consideration of its ever-widening applications and the severer conditions under which it is being constantly used.

Importance of Water Not Realized

Stringent provisions have been provided by national engineering bodies and are used by engineers to cover the composition and character of concrete with the object of rendering structures composed of it as much beyond defect as possible. These provisions are a recognition of the need of adequate specifications to ensure certainty in the ultimate result. The remarkable feature is, however, that the investigations and studies resulting in these specifications have, for the main, been limited to but a portion of the concrete. The cement and aggregates have been made the objects of careful scrutiny and yet these, without water, cannot make concrete. Water is an essential component of concrete but its functions have been very little regarded. Water has a very important effect on the ultimate value of concrete. Examinations of defects will bear this out, and if any great improvement is to be made in the present methods of manufacturing concrete, it will come from a better understanding of the paramount importance of this factor. Excess water, above all things, is proven from actual examination to have a most injurious effect and if improved results are to be assured, a saner practice in proportioning the water portion of the mix must be followed.

In a very enlightening article in Engineering Record, Nathan C. Johnson, consulting concrete engineer of New York, adds to the supply of knowledge on this problem and analyzes the effect of excess water, which he regards as the cause of most concrete failures. The author offers suggestions which, while open perhaps to considerable antagonism, are fully justified by the facts presented. Of such preponderant importance are the principles laid down in the article referred to that we have in the following paragraphs set down the facts most in need of emphasis:—

Day's Work Planes

When structures of concrete subjected to water action in any degree are examined after two or three years of service, the surfaces are found to be discolored, usually along horizontal planes. "Efflorescence" is the explanatory anodyne of apologists; but if the same structure is examined after a longer period, the conditions first noticed are found to be aggravated. Surface stains and unsightliness have gone deeper. Undeniably they are become local disintegrations, with oftentimes heavy surface incrustations below them; and it is thrust upon one's notice that these surface deposits originate and these disintegrations are most pronounced at strata lines where surface staining was first noticed.

"Day's work planes," says the advocate of any old concrete for any and every purpose. "They are natural to concrete." With the majority of concrete work as a basis of judgment, such a dictum is apparently justified, but if it is justified by fact, concrete may not safely be employed when subjected to water action in any degree, for the first surface stains, the later incrustations and the deeper disintegrations bear witness to percolation and removal of material by water along these planes. And if the substance of such planes is examined, it will be found to consist of fine, semi-solid material, chalky when dry, clay-like and slippery when wet, lying in layers of greater or less thickness and bearing little or no resemblance to concrete. This material, known as laitance, comes from the cement; it is part of the concrete.

The Austin Dam Failure

In 1911 the whole country was shocked at the failure of a concrete dam at Austin, Pa. Towns were swept away by the released waters, one hundred lives were lost, millions of dollars of material damage resulted.

Engineering examination subsequent to the disaster emphasized particularly the responsibility of a shale rock foundation, permitting slip of the entire dam. Two engineers laid emphasis upon certain defects noticeable in the concrete, but it is probable that the opinion accepted by the engineering fraternity at large was that the responsibility lay with a poor foundation.

Without disparaging in any sense these factors, it is of interest to an analytical study of defective concrete to notice the surface appearance of this dam before failure, and to endeavor to correlate this appearance with such rupture as occurred under stress of impounded water.

This dam before failure exhibited what might be termed a characteristic concrete surface, showing the marks of form boards in well-defined horizontal lines, with here and there darker lines, indicating the height of a lift of forms, with along and below these lines white extrusions of greater or less extent.

It is of special interest to note that one examining expert in his report to the coroner says, "One section at the west end slid on one of these horizontal construction joints" (day's work planes), and he adds that these "construction joints" are formed of "cement cream." A second engineer also notes that there was a laitance section 10 by 20 feet in surface area near the west end that showed horizontal failure; and he states that "much of this material would have made excellent marking chalk."

Remembering, then, that "day's work planes" are formed from laitance, or "cement cream"; and remembering the characteristics of this substance, light, semi-solid, chalky when dry, slippery when wet, non-adherent to concrete above and below it; remembering, too, the unquestioned existence of at least one large area of laitance at the west end of the structure, can foundation rock, poor though it unquestionably was, be held solely responsible for this failure? And may engineers accept day's-work planes as "inevitable," "harmless" and "natural to concrete"? No condemnation of concrete ever was greater; and, if true, condemnation is also made of any engineer who recommends concrete, except in enormous mass, for any water-exposed service, whether such exposure be to high heads of water, or to ground moisture brought through by negative pressure from surface evaporation.

Excess Water Responsible

Nor is this an isolated instance. Examination of other similar structures shows a noticeable stratification or banding, and even dips or waves as though a stream had plunged with force into a plastic substance, flowing off on either side from the point of delivery. Little imagination is needed to picture repeated batches pouring from a spout at this point. Examination reveals that each wave is outlined in a seam of laitance and the same characteristic leachings and incrustations are evident. Evidently the concrete placed in such structures must have been quite wet to flow sufficiently to form waves, belts and stratifications. More intimate investigation reveals segregation, with percolation made evident by surface crustations. Nor can the conclusion be escaped that excess water, added to save labor of mixing and labor of compacting in forms, is responsible for such planes of weakness in concrete. Yet, laitance is not the only defect resulting from excess water, nor is excess water the cause of all defects. But excess water, either as a prime cause or by aggravating initial deficiencies until they come to have an exaggerated importance in the final result, is of such importance as to be deserving of special attention and study.

Functions of Water

Concrete is a composite, 80 per cent. or more of which is sand and stone. The remaining 10 per cent. is the product resulting from chemical combination between cement and water. But in spite of its percentage minority, this cementing substance has preponderant importance. Water, both in physical and chemical action, is the key substance of concrete.

Water in concrete functions in four ways:

First: Water forms, with cement, the binding material uniting sand and stone. This function consists in (a) dissolving the pulverized cement, with (b) formation of acids from anhydrides; and (c) bringing these new acids and the dissolved bases of cement into sufficiently intimate contact so that they may chemically react.

Second: Water operates to flux these cementing substances into multitudes of minute irregularities on the surfaces of sand grains and stone (or gravel) particles, rendering possible extensive adhesion through crystallization and adsorption as water is absorbed or evaporated.

Third: Water acts as a lubricant between harsh and irregular particles, rendering easy placement in molds and forms.

Fourth: Water itself occupies space in the mass

Chemical Function

The function of water first cited is basic and essential. If there is insufficient water, obviously the reaction of the cement would not be complete; and if there is too much water, it is equally obvious, since for its strength cement depends to a certain degree upon the formation of interlacing crystals, that adequate crystallization cannot take place, since crystallization takes place only from saturated or super-saturated solution. Furthermore, cementing action is dependent to an extent upon the formation of colloids, or non-crystalline, amorphous, glue-like substances. These substances also depend for their strength upon the amount of water combined with them. Undue dilution of these colloids cannot take place without impairment of strength, just as glue (a true colloid) may be a valuable adhesive when of proper consistency, while the same glue, if too dilute (or if too concentrated) may be useless.

What quantity of water is required to properly react with a given quantity of cement is not precisely known. Furthermore, if for no reason other than variance in composition of different brands, hard and fast rules would be impossible.

Excess water in a cement mixture produces segregation, laitance and cracking. In wet concrete and mortar these actions are repeated to an exaggerated extent by reason of the large excess of water commonly employed; and segregation is further aggravated by the relative massiveness of stone particles as compared with the sand and cement particles.

Fluxing and Lubricating Functions

The second function of water—that of fluxing the cementing substance over the surface of sand, cement and stone or gravel particles—is closely related to the foregoing. Cement adheres to these substances by myriad contacts. If the solution is too dilute, or if these minute roughnesses are already full of water, the adhering substance can form but a meager attachment at a relatively small number of points, with proportionate weakness.

The foregoing actions are also closely connected with the third function of water—that of acting as a lubricant between particles. Water is a mobile substance and has high surface tension, so that in confined space, as between sand particles in considerable mass, it may act most effectively in this regard. The advantage to be gained, however, is not commensurate with the quantity of water. When the water content is increased beyond a certain point, segregation of coarser from finer materials invariably takes place, so that what is gained by fluidity in one portion is lost by harshness in the other portions with always very great detriment to the quality of the concrete.

Water a Space Filler

All of the foregoing is intimately concerned with the fourth function of water—that of occupying space. There is no substance more incompressible than water when it is confined. Forms for concrete are essentially confined spaces, care being generally exercised to see that they are made and kept tight. It follows, therefore, that each drop of water in concrete, whether combined or uncombined with cement, occupies a definite, unchangeable amount of space in the mass at the time the form is filled. It further follows, since it is impossible to conceive of this space-occupying water as otherwise than distributed throughout the mass, that dispersion of sand particles and stone particles, with proportionate lowering of mass density must occur. And since the foregoing is true, it is evident that if any part of this water is uncombined, all evaporation or drainage subsequent to setting will leave in the rigid mass hollows of a size equivalent to the spaces occupied by the water; and since this water was evenly distributed, such evaporation or drainage must result in an essentially porous mass.

We are so accustomed to thinking of concrete as a solid that it is somewhat difficult to realize that it is actually porous, 17 to 40 per cent. being air and water voids. It is true that these voids may not constitute continuous passageways, but when this simple statement of void percentages is translated into dollars and cents and it is pointed out that for every $100,000 worth of concrete, from $17,000 to $40,000 is paid for holes, which not only have no value of themselves, but constitute a serious menace to the integrity and usefulness of any structure, the matter is brought more closely home.

Yet to-day, in the majority of concrete structures, these or like defects exist; and the most deplorable part is that at the present time there is little general inclination to better these conditions. But if concrete is to retain its prestige, a standard procedure for concrete work based on real knowledge must be evolved by those skilled in the art, adopted by engineering and architectural bodies vested with authority and recognized and insisted upon universally.

A Suggested Remedy

The unsightliness of day's work planes and their potential danger may, it is true, be recognized to such an extent as to cause provisions in specifications "that if the engineer deems it advisable he may require picking or roughing of the top portion of the work last poured, before pouring the next concrete in order that they may thoroughly bond." How often does the engineer deem it advisable? Such provisions might as well be omitted so far as their adequacy is concerned.

It is virtually impossible to effect adequate removal of laitance after the mass is set. This is especially true in reinforced work, where there is a network of steel. In many such cases adequate removal of laitance would have to be done by knitting needles. The only solution of the problem seems to be either prevention of formation of laitance, through improved methods of making concrete, **or else after a form is filled, the removal of top boards to a point sufficiently low to allow the accumulated fine materials and fluids to flow off until coarse aggregate shows in the deposited mass, the drained materials being wasted.**

This remedy is radical. It will doubtless be subject to ridicule by the unthinking, but if the menace of day's work planes is to be avoided there seems at present no way other than this. Certainly the cost is insignificant as compared to the integrity of a structure and no more than the cost of an equal insurance against loss. When procedures are better perfected, different conditions will obtain, but in the present undeveloped state of the art, some adequate assurance is an imperative necessity.

Suggested Specifications

Advocating concrete drier than present custom sanctions should not be construed as holding any brief for very dry concretes, laboriously tamped in place. One is almost as bad as the other. Yet drier concretes should be used, and to bring about their use it is necessary to so crystallize the growing sentiment against the use of excess water as to make sure the observance of necessary precautions; and to incorporate in specifications such clauses as will as nearly as possible insure the result desired.

Along these lines, the following specifications are suggested:

1. Concrete shall consist of sand, stone (or gravel), cement and water in such quantities as shall be designated by the engineer.

2. The proportions and quantities of all materials, including water, shall be as directed by the engineer and shall be subject at all times to such change as his tests or judgment may dictate as advisable.

3. All materials shall be accurately measured in measures of approved type and known capacity.

Cement shall be measured by the standard sack or, if in bulk, by weight, 94.5 lb. being taken as an equivalent of one sack. Loose measurement of cement is prohibited.

Sand and stone shall be measured in struck measures of a capacity and type approved by the engineer. Measurement in wheelbarrows of a type which do not admit of a struck measurement will not be permitted.

Water shall be measured at each mixer in containers adapted to ready adjustment and to accurate delivery of variable quantities. Supplementing the delivery of such measuring containers by additions of water, because of slowness of discharge or for any other reason, will not be permitted.

4. Concrete of a plastic consistency is required in all parts of the work, unless special permission be given by the engineer for the use of drier and stiffer mixtures. Sloppy and over-wet concretes are strictly prohibited. The quantity of water, therefore, will be subject to regulation at all times by the engineer according to the requirements of the aggregates in use at that time. The rejection and removal of over-wet concrete either before or after placing in forms may at the engineer's discretion be required of the contractor without compensation.

5. After any form or lift of forms has been filled, spaded and allowed an interval of settling not greater than one-half (½) hour, and while the concrete yet remains in semi-fluid condition, the top portion of the forms shall be removed throughout the entire length of the section to such depth as may be required by the engineer and the materials shall be allowed to flow out of the forms and be wasted. This wasting shall be carried to such a depth as will expose coarse aggregate in the mass. Concrete shall not again be deposited on the remaining concrete until the next lift of forms is ready to be filled.

Survey of Municipal Engineering

In his inaugural presidential address to the Institution of Municipal Engineers, Edward Whitwell, F.I.G.E., M.S.A., discussed in more or less detail some of the preponderant problems confronting municipal authorities, and reviewed what had been done hitherto to effect their solution. The matters discussed in his address were, of course, approached from an English point of view, and yet there is much that applied with equal force to Canadian systems and methods, and we therefore adapt from his paper such selections as appear to be of general significance.

The matter of mechanical transportation in municipal departments is one that has not been actively taken up by Canadian municipal engineers, and yet it is a department which is furnishing an ever-changing problem in which an engineer's experience and training may find ample scope. The wonderful developments that have taken place in the mechanical world have made animal traction for most purposes out of date. Like all other very old institutions, the use of the horse dies very hard, indeed, and one fully expects to see, in another decade or two, a few authorities still using this animal for certain classes of work. That at the present moment there are many works in which the horse is more economical than the motor is perhaps true, but, one by one, with increasing experience and with the numerous inventions tending to improve the power plant, they are fast appreciably lessening. At the present stage the concensus of opinion is that for very short journeys the horse still reigns supreme economically—though the electric vehicle is rapidly overhauling it—but for long journeys motors are admittedly more efficient and less costly.

Town Planning.

Town planning is another of the important matters to be solved by municipal authorities. Hitherto municipalities have been laid out in a manner unworthy of the traditions of a great people and still more unworthy of an intellectual community. Fortunately a great change is taking place, and people are beginning to waken to the value of beautiful surroundings, quick transport, and social amenities. That we are far from reaching the high-water mark is still lamentably apparent, and this is chiefly due to the inaccurate perspective of the municipalities in general, who, with limited vision, see only the immediate capital outlay and are blind to the fact that the principal and interest are returned a thousand-fold in the health, happiness, and prosperity of future generations.

Highways.

This very important part of the engineers work looms more and more largely in the people's mind, and is one for which in its present transitory stage it is not so easy to lay down immutable laws as most laymen imagine. With the ever-changing and varied types of vehicle, which now use almost every kind of highway, it is found that it is impossible to lay on any one highway that kind of surface which is suitable to all, and it is fast becoming an accepted fact that a highway must be constructed with a surface that will suit best the major portion of the traffic which it has to carry. Again, it is found that this solution of the problem is not in itself conclusive, for other difficult factors immediately present themselves in the form of position of the highway, the physical characteristics of the district over which it passes, etc.; while the question of cost generally closes the door, in the municipal mind, on the best and most suitable forms. One thing is really most evident, although often overlooked by the carping critic of highways, and that is, that unless an adequate foundation is provided to any form of highway, good surfaces are the exception and not the rule; and how many of the existing highways, unless they have been constructed or reconstructed during very recent years, possess this adequate foundation? Another fact which must be understood is that the best forms of highway surface, given that other conditions are complied with, are undoubtedly the most satisfactory and the most economical, though much more costly than the old forms in initial outlay. Of course, it must be realized that the best form does not necessarily mean the most costly, but rather the

(Continued on page 147)

How Good Roads Affect Land Values

By E. A. James, B.A. Sc.*

WE are not concerned in this article with the desirability, necessity, or the value of good roads, nor with passable or possible roads, nor with good roads—roads firm, clean, inviting for 365 days in a year—but with the abstruse, academic question of land values.

The term "land values" has been used in a restricted or technical sense, but also in an extended sense to include not only the soil, but the mines, forests, and even the water powers. It is, however, in its restricted sense that we here use the term. Land has a value due to nature, to the growth of society, and to the improvements made by industry. We do not propose to separate these elements and here discuss each, because they are so interdependent, but we point them out because "good roads" affect each element in a varying degree. Land values are usually higher in those areas served by good roads and pavements than in the unimproved districts, but at times it may be difficult to analyze values and show to just what extent good roads directly or indirectly affect the values.

Commercial Property Is Increased in Value.

Land may be roughly classified as commercial, residential, and agricultural areas, provided we apply to these three terms their widest meaning. Commercial lands acquire a value from good roads depending upon the use to which they are put. If they are to be used for distributing warehouses, shops, or places of entertainment, passable roads are an absolute necessity, and good roads add much to the value. We have in mind a lot with a frontage of 170 feet on a mud road and a depth of 190 feet to a siding. The lot was 600 feet from a good road and sold for $95 per foot. This was largely a speculative price, because the lot was useless from a business point of view. It was not suitable for a material yard, coal and wood or lumber yard, or a factory site, because for weeks at a time the road leading to it was impassable; therefore, it remained unused and its value purely speculative.

In about one year from the time of the above mentioned sale a pavement was constructed, connecting the lot with a leading roadway, on which material was distributed to a large and populous area. The roadway cost the lot owner $5.50 per foot frontage, but it at once gave the land a commercial value, and the lot was sold for $150 per foot to a company handling builders' supplies, etc., and they are now carrying on a business that gives a good return on the money invested, including land values. Good roads, in this case, converted speculative values into established commercial values. Without good roads, in many cases, lands in commercial or business areas are without a real value.

Improved Roads May Reduce Values.

Of course, it is equally true that good roads and good roads alone will not increase land values in a commercial area. They will lower land values in these areas just so soon as streets and lanes are paved in this district beyond the area required by the community for commercial purposes. Take a district that requires for storage yards, elevators, etc., a half-mile of railway front. This section is well served with a good pavement, and there is no room for another yard to operate profitably. By extending your pavement another half-mile you do not increase values in this new area, because it is useless; and, if there is one buyer, you lower values instead of increasing them, because you increase the number of possible sites and introduce competition.

In residential areas land values are not so susceptible to the influence of good roads. In certain districts the vast majority of people walk, and the delivery wagons are not a necessity. Here a pavement may not increase the value of land more than the cost of the pavement.

Conditions in Residential Districts.

A suitable pavement in a residential area would cost approximately, for a 12-foot lot, $12 per year. And just as long as the tradesmen and supply houses do not put on a tax or additional price for delivery in unpaved areas just so long will pavements in these cheaper residential areas reduce land value. In residential areas where motors are used land values are increased by good pavements, provided the area paved does not exceed the area required for residential purposes. Just as soon as the area paved exceeds the area required land values will decline. Taxes, interest, and idle money will force owners to sell at a loss.

In a promising residential area lots were selling at $28 per foot frontage. The street was paved, and immediately the sales were recorded at $35 per foot, an advance of $7 per foot on an expenditure of $2.15 per foot, while parallel streets just as desirable remained at the old price of $28 per foot.

The more expensive residential areas have their land values increased, within limits, but the degree of increase depends on the use which the residents of the street make of it for pleasure purposes, not upon the commercial aspect of delivery of goods.

Values Are Increased if Tax Is Low.

It is in the agricultural areas that the effect of good roads on land values is difficult to specify. After examining a number of specific areas we make, however, this general statement, that good roads touching the property increase farm land values until the annual good road tax represents 1 per cent. of the land values, and enhance values of land within a distance, by the road, of two miles, until a tax of ¾ per cent. of the land value is reached. When the tax goes beyond that limit it tends to lower agricultural land values, and unless the property can be converted into residential or "avocational" farming areas, good roads become a burden and will lower land values in a marked degree. All agricultural lands do not require for their highest development good highways, and there are many instances where the social and intellectual advantages highly desirable in any community can best be secured by abandoning the land for certain periods.

In those areas where mixed farming is followed, and where the population reaches one person per twenty acres, as in the rural areas of Wentworth, Norfolk, Simcoe, York, Dundas, etc., the increase in land values due to good roads is not difficult to calculate. Agricultural lands acquire a value due to their natural fertility, their suitability for producing certain products, their access to the market, and the possibility of enjoying, while earning a living, a healthful, moral, and social atmosphere, surrounded with those comforts of to-day which are the necessities of to-morrow.

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A concrete case will best illustrate values. A farm of 110 acres sold in 1910, including good farm buildings, for $90 per acre. In 1911 a good road was promoted past the farm and the farm was re-sold for $105 per acre. In 1914 the road was completed in front of the farm, but not to the market, when it was again sold at $110 per acre. The road tax in this case was less than 1/10 of 1 per cent.

Bring Producer and Consumer Together.

Good roads assuredly increase farm land value, and unless the tax becomes a burden, never decrease, for, differing from commercial and residential areas, the volume of production of similar commodities creates favorable shipping facilities, and thus improves prices to the producers. Good roads in rural communities are an important link in the line of communication from producer to consumer, and, since the producer pays the larger proportion of transportation, cheaper transportation must increase producing land values.

Stone and Concrete Foundations from the Standpoint of Efficiency and Economy

By G. C. Warren*

"ECONOMY and efficiency" have come to be commonly used together as a high-sounding expression of which one almost stands in awe. To my mind, with all its grandeur, "economy and efficiency," in its most extreme application, is well embraced in the one little word "best," when that word is used in its broadest sense of "all things considered."

An engineer who would say that any one type of road or pavement foundation or surface is "best" or "most efficient and economical" under all conditions would be like an architect who claimed that either stone, brick, concrete, or lumber is the best building material for all conditions.

In my judgment ,the question of "best" or more "economical and efficient" pavement foundation (as to both character and depth) to meet any particular case, necessarily entails a careful study and consideration of the conditions applying to that case, including the character of subsoil, character of traffic, character of wearing surface to be laid on the foundation, and climatic conditions.

As a general statement applying to new pavements, I think a statement on this subject, made by the company with which I am associated, in its instructions issued fifteen years ago, and maintained at all times since then, covers the ground as well as it could be covered in a few words:. This is as follows:

> An unyielding foundation is essential. Our specifications for bituminous base are designed for characters of subsoil which can be rolled to provide a firm sub-foundation. Where unyielding subsoil conditions do not exist, or where the roadway is so narrow or contains such obstructions as to make proper rolling of foundation impossible, the use of hydraulic concrete is recommended, being very careful that the concrete is roughened as specified. It frequently occurs, and cannot always be foreseen, that different portions of the same street, with a view to economy and utility, require different thicknesses as well as characters of foundation; for this reason it is advisable that specifications should provide for payment for the foundation per cubic yard, and prices for both bituminous and hydraulic concrete foundation.

In the fifteen years which have elapsed since the formulation of this rule I have seen nothing to indicate that, as between crushed stone and hydraulic cement concrete foundation it is not absolutely correct, axcept as noted below in the case of sandy subsoil under certain conditions. I, however, freely confess that I have seen many cases of mismanagement and the use of crushed stone foundation undersubsoil and other local conditions where such a foundation should not have been specified, and also the adoption of expensive concrete foundation under subsoil and other conditions which make such adoption a lack of true economy to an extent that, to my mind, constitutes incompetence.

In discussion of this matter "concrete" is considered as including any dense aggregate ranging from coarse to fine, the particulars of which are bound together by any cementing agent, whether hydraulic cement, bituminous cement or other cement.

Block Pavements.

I will assume it to be a pretty generally recognized fact that all forms of block pavement must be laid on concrete base, for the reason that broken stone base does not provide a bed on which the blocks can rest without danger of rocking under traffic. Incidentally it will also be generally conceded that, unless the blocks are more completely and firmly grouted than is practicable on the entire area of pavement, it is necessary that the depth of concrete foundation shall be greater than the foundation for a monolithic wearing surface. The reason for this is that in the case of the block pavement the weight transmitted to the foundation is that of the load resting on individual block areas, while in the case of monolithic surfaces the weight of the same load transmitted to the foundation is distributed over many times greater area. The use of a broken stone foundation is, therefore, practically limited to monolithic bituminous wearing surfaces.

Broken Stone Foundations.

Each individual case should be given special consideration, with special reference to the character of subsoil and climatic conditions. If the subsoil is of the nature of clay and the climate such that the sub-base is liable to become wet before the waterproof pavement surface is laid, then it is unsafe to specify broken stone base, because in such wet yielding condition the subsoil does not provide a sub-grade over which either the crushed stone or bituminous surface can be properly compressed. If, on the other hand, the subsoil is of a gravelly nature, or if in a climate where it seldom or never rains during the working season, no more serviceable or inexpensive foundation can be produced for a stable bituminous wearing surface than a thoroughly rolled crushed stone.

This has been abundantly proven in many cases, of which I will cite two.

Sandy Subsoil.

Nearly sixteen years ago we had great difficulty in securing a solidly compacted broken stone foundation on the sandy soil of one of the lake cities of Indiana. The spreading of marsh grass over the sandy subgrade before spreading the crushed stone helped immensely. During the present year, however we met an interesting case in connection with the building of a bithulithic pavement on the bridge approaches of the "Interstate Bridge" crossing the Columbia River from near Portland, Ore., to Vancouver, Wash. The bridge floor is 21,624 square yards, and the bithulithic pavement was laid on heavily reinforced Portland cement concrete foundation. The bridge approaches are about three miles in length, and are formed of sand pumped from the Columbia River, the newly-made fill thus made having depths varying from five feet to twenty-five feet. Being washed in place, the sand fill is compressed as solidly as possible. The specifications required a broken stone base, laid on this sand fill. The general belief is that, under such conditions, the crushed stone, in rolling, will compress several inches into the dry sand, and even then not be solidly compacted. It has, however, been proved that a generous amount of water used to wet the sand during the process of spreading and rolling the base, provides a subgrade so solid that the stone compresses into it but very slightly, and becomes solidly compacted under the twelve-ton steam roller, and, using the same heavy roller, no trouble develops in compression of the bitulithic wearing surface.

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*Before the American Society for the Advancement of Science

Economic utility of broken stone foundations is especially applicable in the case of old macadam country roads or city streets, the grade and contour of which are such that they can be regulated without serious disturbance of the old macadam.

It is a well established fact that with a dense, stable, waterproof pavement surface, rolled crushed stone base practically overcomes the cracking of Portland cement concrete. It is also self-evident that a crushed stone foundation has the important economic advantage that in the case of a broken stone base the bituminous wearing surface, under pressure of the roller, fills the chinks in the surface of the foundation and forms an important union between the foundation and surface which is impracticable in the long run with either Portland cement concrete or silicate of soda concrete foundations.

Concrete foundations are divided into three general classes—Portland cement concrete, bituminous cement concrete, concrete bound together by other classes of cement.

As previously stated, in cases of weak sub-base, solid, dense concrete has an important advantage, in that by bridging over the weak sub-base it imparts a greater strength than is possible with rolled crushed stone under such circumstances. Taking the subsoil conditions throughout the United States and Canada as a whole, in a large proportion of cases, doubtless, the subsoil and climatic conditions are such as to make the use of "concrete" desirable, but, as noted above, this is not at all a universal rule.

Well-made Portland cement concrete base of the conventional proportions of one part cement, three parts fine aggregate, and six parts coarse aggregate, has a greater crushing and tensile strength than either broken stone or other types of concrete, but it is well established that a slab of Portland cement concrete laid on more or less damp subsoil will necessarily crack, and, where cracks occur in the foundation, then cracking of the pavement wearing surface is sure to follow. In many cases such cracking is the lesser of two evils, and in such cases there can be no doubt but that Portland cement concrete is the best, and, therefore, the most economical and efficient pavement foundation, but this condition is not at all universal nor even nearly so.

Bituminous concrete—i.e., concrete in which the well-proportioned, coarse and fine aggregate, which may be either natural gravel and sand or crushed stone and sand are heated and mechanically mixed with suitable bituminous cement and spread and rolled on the previously compacted sub-grade—has the extremely important advantage of absolutely overcoming the cracking of Portland cement concrete foundations. It also has the least equally if not more important, advantage of a thoroughly united and unified foundation and surface, the two courses being of the same class of materials.

During the past year the laboratory of the company with which I am associated has done a great deal of work investigating the use of silicate of soda as the cementing material for concrete foundations and finds that, in connection with a substantial waterproof bituminous wearing surface, which is also necessary to secure highest efficiency with Portland cement concrete, it is quite practicable to make high grade a foundation in this way. The question is one of relative prices of Portland cement and silicate of soda, and consequent first cost of construction. We have also successfully laid a wearing surface over concrete made of silicate of soda and crushed stone, in Sudbury, Ont. The silicate of soda concrete has greater resiliency and less rigidity than Portland cement concrete, and apparently materially lessens, if it does not entirely overcome, the cracking of Portland cement concrete foundation.

Tests on Asphalt Materials

A PAPER on "Sheet Asphalt Pavements," read before the Canadian Society of Civil Engineers by T. L. Crossley, was published in part in the Contract Record of January 17, page 51. In addition to the extract therein printed the author described the usual tests required of and performed on asphalt materials and the methods of inspection to ensure high quality. In the following paragraphs an outline is given of these test and inspection requirements:

Tests of Asphalt Material.

Good, refined asphalt and asphaltic cement should not show a hardening of more than 10 or 15 points, and will not lose more than a fraction of 1 per cent. Trinidad and Bermudez asphalts lose a little more than those prepared from Mexican asphalts. A recent sample of Bermudez refined tested by the writer lost about 1.5 per cent.

Other tests made are solubility in carbon bisulphide and carbon tetrachloride and ductibility. The last is made by measuring the distance. A bignette having a cross section area of one square centimeter at its centre will stretch horizontally before it breaks. Good "A.C.'s" should run over 100 centimeters when pulled apart at 77 degrees F. at a rate of 10 centimeters per minute. The thread produced as the pulling proceeds varies in thickness a great deal; some at 100 to 110 cm. show a strong line of about the size of No. 60 thread, while others at the same length show such a fine filament that a glass has to be used to look for breaks.

Tests not always made, but having more or less value for comparing samples as to uniformity and for determining whether the heating has been carefully done, are: Fixed carbon, ash, flash point, proportion of paraffin scale and solubility in naphtha (76 or 86 degrees gravity should be stated).

The fixed carbon test had come into undue prominence because too narrow limits have been set for it. The test is subject to fairly wide personal factor, depending on the difficulty of securing exactly similar conditions at different laboratories. It consists, briefly, in strongly beating one gram of the bitumen away from the air for a stated length of time, producing a coke as in the proximate analysis of coal. The weight of the system is then taken, and it is burnt in the air to ask, the difference being the fixed carbon. The thickness, depth, and volume of the crucible, the height and intensity of the flame, and the time of heating all affect the results, so that this test must not be considered as an exact one. It yields valuable information sometimes as to the past history or origin of the bitumen in question. California asphalts yield a lower fixed carbon for the same class of material than Mexican for instance. The ash test also serves to show something of the past of asphalt. For instance, if a refined asphalt was said to be Trinidad and showed only 10 per cent. ash we would know it was not straight goods. Low flash point asphalts would be dangerous to workers owing to the necessity of high temperatures in mixing machinery and melting tanks.

Inspection.

When tenders are submitted it is the custom to submit samples of asphalt, asphaltic cement, and flux. Now, as previously noted, it is becoming the practice to ship asphaltic cement ready for use without flux, which makes it merely necessary to submit one product for examination. It is always advisable besides determining the suitability of a sample and its compliance with specifications, to learn something of its history. Cases have been known where samples of one make were submitted as being of different brands. The engineer or chemical engineer charged with the inspection should make a personal visit to the plants which the asphalt is to be shipped from, and note its manner of shipment and the means taken there to control the product.

When the paving is to be done by a separate contract from the supply of material it will be necessary, of course, to check quantities received as well as quality. If the contract is to supply a finished pavement, the quality only of the bitumen is to be noted, and, of course, the proportions of the aggregate.

The mixing plant should be closely examined and tested as to the capacity and sensitiveness of its weighing and mixing machinery and method of heating. The means for maintaining a sufficiently high temperature without overheating the material is an important point. With a substance that has such a low conductivity as asphalt direct heat must be used with great care, especially in starting up with cold material. Some means of circulation should be provided until the material is liquid enough to circulate by convection, and even then should be stirred occasionally to prevent burning at the bottom.

The sand should be heated to the same temperature as the bitumen. While no damage will accrue to the sand by heating to higher temperatures, there is a risk of the asphalt being damaged or burnt by overheated sand. The same consideration affects the heating of the crushed stone used in the binder course mixture.

At a plant of any size an inspector should be employed continuously. It would be his duty to see that the weighing apparatus is kept efficient, that asphalt is not overheated or allowed to get so cooled as to cause the mixture to become lumpy at the laying point, that sand or crushed stone is clean, of proper grading, and heated to the right temperature. He should have a small, clean room for his own use entirely, a scale weighing up to two or three kilos and sensitive to 1 gram, and a set of sieves from 200 mesh to 1 in. ring. It would be well, also, to have a penetrometer and dishes for this test, with a supply of water. The penetration tests, however, would usually be done by the city chemist at the main laboratory. In connection with sand test at 200 mesh, or for the testing of dust or cement as filler, there should be provided a graduated cylinder about ¾ in. diameter, holding a little over 50 cubic centimeters graduated to 0.5 cubic centimeters, to test the proportion of suspendable matter which is the true filler. Seventy-five per cent. of the 200 mesh material should be of such a degree of fineness that on shaking it up with water it will remain in suspension at least 15 seconds.

Survey of Municipal Engineering

(Continued from page 143)

most efficient, having regard to durability, imperviousness, noiselessness, and self-cleanliness.

Sewerage and Sewage Disposal.

The effective advances that have been made in this department during recent years call for much congratulation; but, great as the advances have been, many more are necessary before we can rest content in the belief that the problem has been finally solved. In the matter of sewerage, I think it may generally be conceded that we are nearing the final disposition of all doubtful problems, and if other departments of public service which are equally vital to the welfare of the dwellers were on as satisfactory a basis, our death, infectious disease, and kindred rates would show a much more satisfactory condition of things.

Water Supplies.

This is a department which falls to the lot of many engineers to control and, outside the construction of the great bases of supply, chiefly takes the form of administration. With the provisions made to safeguard the purity of the water, which is probably the first essential to human existence after air, most engineers are well acquainted, while hard-and-fast rules are generally in existence to secure uniformity of distribution. In any event, it is fully recognized that the greatest dangers to the pure supplies of water lie in the distributing channels rather than at the base; hence every precaution should be taken to prevent possible sources of contamination being contiguous thereto.

As is well known, one of the greatest troubles of distribution in some districts is that traceable to corroded mains; and, while ingenious contrivances have been found by means of which periodical cleansing can take place, yet none of them safeguard the smaller pipes from the same evil, and consequently an enormous expense is annually incurred in replacements. That some means of actually arresting the corrosion would be infinitely more satisfactory is evident, and I am rather looking to the introduction of some preparation, by a treatment of the conveyers, to bring this about on the principle that prevention is better than cure.

Specifications for Concrete Floors

Suggested Recommendations Covering Preparation, Laying and Finishing of Plain and Reinforced, Single and Double-Course Floors

THE following suggested specifications for concrete floors, incorporated in a pamphlet issued by the Portland Cement Association apply to floors in buildings, whether subjected to moderate or heavy traffic, and cover the laying and finishing of the floor; also its protection during early hardening.

GENERAL REQUIREMENTS

Materials

1. **Cement**: The cement shall meet the requirements of the current Standard Specifications for Portland Cement adopted by the American Society for Testing Materials. The cement when used shall be in perfect condition and contain no lumps which cannot be pulverized between the fingers.

2. **Aggregates**: Before delivery on the job, the contractor shall submit to the architect or engineer a fifty (50) pound sample of each of the aggregates proposed for use. These samples shall be tested, and if found to pass the requirements of the specifications, similar material shall be considered as acceptable for the work. In no case shall aggregates containing frost or lumps of frozen material be used.

(a) Fine Aggregate: Fine aggregate shall consist of natural sand or screenings from hard, tough, crushed rock or gravel, consisting of quartzitic grains or other equally hard material graded from fine to coarse, with the coarse particles predominating. Fine aggregate, when dry, shall pass a screen having four (4) meshes to the linear inch; not more than twenty-five (25) per cent. shall pass a sieve having fifty (50) meshes per linear inch; and not more than five (5) per cent. shall pass a sieve having one hundred (100) meshes per linear inch. Fine aggregate shall not contain vegetable or other organic matter nor more than three (3) per cent. by weight of clay or loam. Field tests may be made by the architect or engineer on fine aggregate as delivered at any time during progress of the work. If there is more than five (5) per cent. of clay or loam by volume in one (1) hour's settlement after shaking in an excess of water, the material represented by the sample shall be held pending laboratory tests.

Fine aggregate shall be of such quality that mortar composed of one (1) part Portland cement and three (3) parts fine aggregate, by weight, when made into briquets, shall show a tensile strength at seven (7) and twenty-eight (28) days at least equal to the strength of briquets composed of one (1) part of the same cement and three (3) parts Standard Ottawa sand, by weight. The percentage of water used in making the briquets of cement and fine aggregate shall be such as to produce a mortar of the same consistency as that of the Ottawa sand briquets of Standard consistency. In other respects all briquets shall be made in accordance with the methods of testing cement recommended by the American Society for Testing Materials. (See Cement Specifications A. S. T. M.)

(b) Coarse Aggregate: Coarse aggregate shall consist of clean, hard, tough, crushed rock or pebbles graded in size, free from vegetable or other organic matter, and shall contain no soft, flat or elongated particles. The size of the coarse aggregate shall range from one and one-half (1½) inches down, not more than five (5) per cent. passing a screen having four (4) meshes per linear inch, and no intermediate sizes shall be removed.

(c) No. 1 Aggregate for Wearing Course: No. 1 aggregate for the wearing course shall consist of clean, hard, rough, crushed rock or pebbles, free from vegetable or other organic matter, and shall contain no soft, flat or elongated particles. It shall pass when dry a screen having one-half (½) inch openings and not more than ten (10) per cent. shall pass a screen having four (4) meshes per linear inch.

3. **Mixed Aggregate**: Crusher-run stone, bank-run gravel or mixtures of fine and coarse aggregate prepared before delivery on the work shall not be used.

4. **Subbase**: Only clean, hard material, such as coarse gravel or steam-boiler cinders, free from ash or particles of unburned coal, shall be used in the subbase. (Note: Eliminate this clause when sub-base is not required.)

5. **Water**: Water shall be clean, free from oil, alkali or vegetable matter.

6. **Color**: If artificial coloring matter is required, only those mineral colors shall be used which, in the amount hereinafter specified, will not appreciably impair the strength of the cement.

7. **Reinforcement**: The reinforcing metal shall meet the requirements of the current Standard Specifications for Steel Reinforcement of the American Society for Testing Materials. It shall be free from excessive rust, scale, paint or coatings of any character which will tend to reduce or destroy the bond.

8. **Joint Filler**: The joint filler shall be a suitable compound that will not become soft and run out in hot weather, nor hard and brittle and chip out in cold weather; or, prepared strips of fibre matrix and bitumen as approved by the architect or engineer. The strips shall be one-half (½) inch in thickness and their width shall at least equal the full thickness of the slab.

Measuring and Mixing

9. **Measuring**: The method of measuring the materials for the concrete or mortar, including water, shall be one which will insure separate and uniform proportions of each of the materials at all times. A sack of Portland cement (94 pounds net) shall be considered as one (1) cubic foot.

10. **Machine Mixing**: All concrete shall be mixed by machine except when the architect or engineer shall otherwise permit under special conditions. A batch mixer of an approved type shall be used. The ingredients of the concrete or mortar shall be mixed to the specified consistency, and the mixing shall continue for at least one (1) minute after all the materials are in the drum. Raw materials shall not be permitted to enter the drum until all the material of the preceding batch has been discharged.

11. **Hand Mixing**: When it is necessary to mix by hand, the materials shall be mixed dry on a water-

tight platform until the mixture is of uniform color, the required amount of water added, and the mixing continued until the mass is of uniform consistency and homogeneous.

12. Retempering: Retempering of mortar or concrete which has partially hardened, that is, remixing with or without additional materials or water, shall not be permitted.

Protection

13. Treatment: As soon as the finished floor has hardened sufficiently to prevent damage thereby, the floor shall be covered with at least one (1) inch of wet sand, or two (2) inches of sawdust, which shall be kept wet by sprinkling with water for at least ten (10) days.

14. Protection: The freshly-finished floor shall be protected from hot sun and drying winds until it can be sprinkled and covered as above specified. The concrete must not be damaged or pitted by raindrops, and the contractor shall provide and use when necessary sufficient tarpaulins to completely cover all sections that have been placed within the preceding twelve (12) hours.

15. Temperature Below 35 Degrees Fahrenheit: If at any time during the progress of the work the temperature is, or in the opinion of the architect or engineer will within twenty-four (24) hours drop to, 35 degrees Fahrenheit, the water and aggregates shall be heated and precautions taken to protect the work from freezing for at least five (5) days.

REINFORCED CONCRETE FLOORS

For reinforced concrete floors the following will apply in addition to the general requirements:

16. Forms: The forms shall be substantial, unyielding and so constructed that the concrete will conform to the designed dimensions and contours, and shall also be tight to prevent the leakage of mortar. The supports for floors shall not be removed in less than ten (10) days after the concrete is placed, and then only with the consent of the architect or engineer in charge. When freezing weather occurs, the supports shall remain in place an additional time, equal to the time the floor has been exposed to freezing.

17. Reinforcement: Reinforcing metal shall be provided as called for on the plans. It shall be placed as indicated and mechanically held in position so that it will not become disarranged during the depositing of the concrete. Whenever it is necessary to splice tension reinforcement, the character of the splice shall be such as will develop its full strength. Splices at points of maximum stress shall be avoided. Splicing by lapping bars without contact and with space between bars along the over-lap equal to twice the thickness of the bars is preferable to mechanical splices or clamps.

Concrete Slab

18. Proportions: The concrete shall be mixed in the proportions by volume of one (1) sack of Portland cement, two (2) cubic feet of fine aggregate and four (4) cubic feet of coarse aggregate.

19. Consistency: The materials shall be mixed wet enough to produce a concrete of a consistency that will flow into the forms and about the reinforcement, but which can be conveyed from the mixer to the forms without the separation of the coarse aggregate from the mortar.

20. Placing: The concrete shall be placed in a manner to insure a smooth ceiling, and thoroughly worked around the reinforcement and into the recesses of the forms. Concrete shall be deposited in its full position as soon as possible after mixing and within thirty (30) minutes after the water has been added to the dry materials. It shall be struck off to a surface at least one (1) inch below the established grade of the finished surface of the floor. Workmen shall not be permitted to walk in freshly-laid concrete, and if sand or dust collects on the base, it shall be carefully removed before the wearing course is applied.

21. Joints: When it is necessary to make a joint in a floor slab, its location shall be designed by the architect or engineer; joints to be vertical.

Wearing Course

22. Proportions and thickness (Mixture No. 1): The mortar shall be mixed in the proportions of one (1) sack of Portland cement and two (2) cubic feet of fine aggregate. The minimum thickness shall be three-quarters (¾) inches.

23. Proportions and thickness (Mixture No. 2): The mortar shall be mixed in the proportions of one (1) sack of Portland cement, one (1) cubic foot of fine aggregate and one (1) cubic foot of No. 1 aggregate for wearing course. The minimum thickness shall be one (1) inch.

24. Consistency: The mortar shall be of the dryest consistency possible to work with a sawing motion of the strikeboard.

25. Placing: The wearing course shall be placed immediately after mixing. It shall be deposited on the fresh concrete of the base before the latter has appreciably hardened, and brought to the established grade with a strikeboard.

Note: When placing the wearing course after the concrete slab has hardened, eliminate paragraph 25 and substitute the following:

26. Preparation of Slab: The surface of the slab shall be thoroughly roughened by picking, and swept clean of all dirt and debris.

27. Placing: The slab shall be thoroughly moist but free from pools of water when the grout and mortar for wearing course is placed. A neat cement grout shall be brushed on the surface of the slab, the wearing course immediately applied and brought to the established grade with a strikeboard. Grout and mortar shall be used within forty-five (45) minutes after mixing with water.

28. Finishing: After the wearing course has been brought to the established grade by means of a strikeboard, it shall be worked with a wood float in a manner which will thoroughly compact it and provide a surface free from depressions or irregularities of any kind. When required, the surface shall be steel-troweled, but excessive working shall be avoided. In no case shall dry cement or a mixture of dry cement and sand be sprinkled on the surface to absorb moisture or to hasten the hardening, but the Bruner method may be used if desired.

29. Coloring: If artificial coloring is used, it must be incorporated with the entire wearing course and shall be mixed dry with the cement and aggregate until the mixture is of uniform color. In no case shall the amount of coloring exceed five (5) per cent. of the weight of the cement.

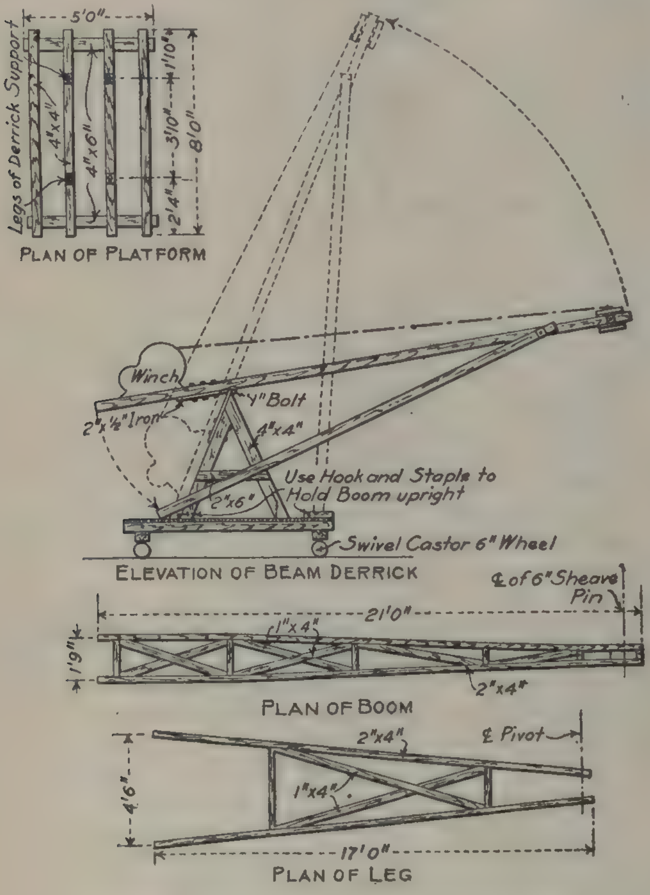
(To be continued)

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Hinged Traveller on Casters Hoists Forms

One of the travellers shown in the illustration, operated with a hand crab by four men, handled all the forms from each floor level to the next for each unit on a large reinforced-concrete building. The traveller, as shown in the accompanying sketch, consisted of a framed boom of light timbers hinged near its lower end on a long bolt passing through the top of a low frame built on a square timber platform mounted on four large casters. The crab was set on the lower end of this boom at such a distance below the hinge as to balance the boom almost perfectly. The boom was held in position when raised by two planks, hinged to it near its upper end, and footed on the forward corners of the platform.



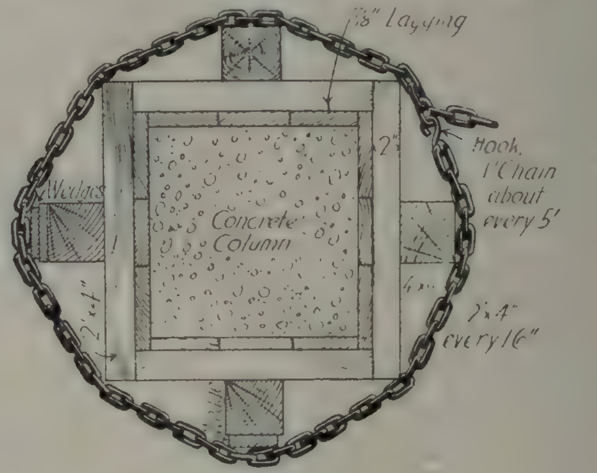
A light traveller with hinged boom for hoisting forms

In use, the rig would be set in an elevator shaft or at the edge of a completed section of the floor above. As the forms were stripped, the panels would be carried short distances and piled under the end of the boom.

Two men hooked them on to these piles as they were made and hoisted them to the level above, where two other men landed them. It frequently happened that before all the forms were stripped which it was desirable to hoist at a given point, the work had progressed until the traveler was standing, surrounded by concreted formwork, in a hole temporarily left in the floor above. It was for this reason that the boom was hinged. This only made it necessary to leave a sufficient opening in the forms of the upper floor to permit swinging the boom down to a horizontal position. The traveller could then be rolled along the floor below by the two men at that level to the next point where it was wanted.—This item is taken from Engineering Record.

A Simple Column Form Tie

In the construction of reinforced concrete columns forms may be tied in a number of ways. One of the most simple methods is that shown in the illustration, taken from Cement World. The lagging is spiked to wales spaced about every 16 inches vertically, as in common practice. A 4-inch by 4-inch timber is then placed along the entire length of the column, centered on the wales, on each side of the column. Chains are wrapped tightly around the form, at intervals of about five feet, and hooked down as shown. Wedges driven between the chain and the vertical timbers will tighten the whole form.



A tie for column forms

The chains are usually placed between wales, rather than in the position indicated in the illustration. Care must be taken to have the chains wrapped in a horizontal plane, since when in other positions there will be a tendency to slip. In addition to the ease and rapidity with which the forms may be erected by this method, there is also the like advantages obtained in the removal of the forms from the finished columns. It is simply necessary to drive out the wedges in order to loosen the forms.

New Westminster, B. C., shipyards are working full time.

Building and Construction Throughout Canada Well Sustained

IN nearly all branches of industry, continued activity is apparent, says the Labor Gazette of January. Building and construction showed the usual falling off with the setting in of winter weather, but inside work on commercial buildings and extensions to industrial plants afforded a considerable volume of employment in many centres. General building operations in the Maritime Provinces were reported fairly well sustained; Sherbrooke reported that notwithstanding the winter season building was brisk; at other points in Quebec, however, building was quiet except where inside work was being carried on. Toronto reported building active, construction being well advanced on a number of large contracts, which were expected to give work to inside trades during the winter; there was a marked scarcity of houses at a moderate rental, and a large number were being erected in the suburbs. Owing to cold weather numbers of workers were laid off from work on the Parliament Buildings, Ottawa. Hamilton reported building active for the season, a number of extensions being made to factories and schools. At Kitchener numbers of building tradesmen were well employed on extensions to factories. At London building operations were practically completed for the season, building tradesmen securing employment in factories. Winnipeg reported building almost over for the season, but at Brandon building tradesmen were active. A number of other points in the West reported considerable activity in building and in repairs.

Railway construction was quiet, as usual at this season. Railway work in connection with the ocean terminals at Halifax was about completed and it was expected labor would be laid off; the new terminals were nearing completion; temporary freight sheds were erected on the piers and berths made ready; contractors had a large number of men at work on the unfinished portions; the Furness-Withy pier was also nearly completed. Dredging at Courtenay Bay, St. John, was suspended early in the month and the entire plant laid up. Work on the new Welland ship canal was suspended at the end of the month and a large number of men released. Vancouver reported railway construction on the different lines closed down and a large number of men coming into the city.

Mainly Constructional

East and West—From Coast to Coast

The Mack Brick Company, Ltd., has been incorporated, with a capital of $500,000; head office at Montreal.

The Grand Mere-Three Rivers Highway Company, Ltd., has been incorporated, with a capital of $63,000; head office at Grand 'Mere. The company will build and repair roads, etc.

As the first step towards the establishment of a big shipbuilding plant at Vancouver the firm of John Coughlan & Sons recently took out a building permit for the erection of machine shops and mould loft at False Creek.

The building permits issued in Welland, Ont., during the month of January, this year, are valued at $2,515, as compared with $4,613 for the corresponding month last year.

Eight additional 160 h.p. Bolinder fuel oil engines—making a total of 24 engines of this size supplied to British Columbia shipbuilding firms for use in the auxiliary sailing vessels under construction—reached Vancouver recently, consigned to the Taylor Engineering Company, Ltd., Vancouver, who have handled the orders in most satisfactory fashion. The engines were built at Stockholm, Sweden.

In the month of January, 1917, there were [illegible] permits issued in the City of Montreal, at an estimated value of $249,895. This compares with 44 permits in January, 1916, value $174,160, and 73 permits in January, 1915, value $203,261

The building permits issued in Vancouver during January, 1917, show a substantial increase over the corresponding month last year. The figures for January this year are 37 permits, at $29,045, while in January, 1916, there were only 18 permits issued, at a value of $8,315.

The construction of an interprovincial railway from Banff Alta., to Windermere County, B.C., is under consideration by the Department of Public Works, Ottawa, and the British Columbia Government. The project will come up for discussion in the British Columbia Legislature this spring.

The city architect's department of Toronto is preparing for active building operations this year. The scarcity of houses entailed by the great dullness of the building trade during the past three years is expected to cause a greater demand during 1917, with a consequent activity in the trade.

The Provincial Government of Manitoba have been requested by the Union of Municipalities to enact legislation providing for the provincial system of good roads which has been under contemplation. The matter is in the hands of the Department of Public Works. It is estimated that the expenditure would be about $8,000,000.

Work has been started on clearing up the wreckage of the coal unloading bridge at the New Ontario Dock, Sault Ste. Marie, Ont., which was blown down in a windstorm last October, and the re-erection of the bridge will be commenced as speedily as possible. The work will be carried out by the Cleveland and Erie Bridge Company.

The clerk of Halton County, Ont., recently received notice that the Toronto and Hamilton Highway Commission would appeal to the Ontario Railway and Municipal Board to compel the county to pay over $14,076.50 of the $16,730.50 which is the estimated cost of the proposed new bridge at Bronte. The county will oppose the appeal.

A new industry has located in Vancouver, known as the Maritime Motor Company. This firm has the exclusive rights to manufacture the only type of gasoline-driven mining and logging locomotive built in Canada. The Dominion Safe Works will also establish in Vancouver in the near future, a site having been secured on the industrial island.

During the month of January, 1917, building permits in Toronto were issued for work estimated to cost $3,114,143, an increase of $2,749,322 over the same month last year. The $2,500,000 permit for the big departmental store to be built at College and Yonge streets is included in last month's figures, but, even leaving out this amount, a substantial increase is shown.

Repair shops for engines and cars of the Great Northern and the Northern Pacific railways will be constructed in connection with the union depot which is now nearly completed on False Creek, Vancouver. The construction of the new station will be completed about May of this year, according to the opinion of Engineer Ford of the Great Northern. The work is being rapidly rushed to completion.

Mr. P. A. Macdonald, public utilities commissioner for Manitoba, stated in his first annual report, recently tabled in the legislature, that investigation of the aqueduct of the Greater Winnipeg Water District by experts assures the public that the aqueduct will fulfill the work for which it was designed, and that no uneasiness need be felt. With reference to the mining industry in Manitoba, he said that eight special certificates to mining companies had been issued. His report goes on to say: "Development of the mining industry in the Rice Lake district and north of The Pas is attracting attention, as indicated by the number of enquiries received, and there is every reason to believe that this province will, in the near future, have remarkable mining development."

A scheme for the construction of a water and drainage system, to cost about $180,000, has been ratified by the proprietors of Montreal South. This drainage system will connect with the proposed intercepting sewer for the South Shore or with an outlet into the St. Lawrence. Preliminary plans have been prepared by Mr. E. Drinkwater, of St. Lambert.

A new moving picture theatre is to be erected in Montreal, on the site of the present "London" Theatre, on St. Catherine Street West, opposite Phillips Square. The building will be fireproof, constructed of concrete and steel, with a solid steel roof. The outside walls of the old building will be left standing, and will be used in the construction of the new theatre. The seating capacity will be 1,200—750 on the main floor and 450 in the balcony.

The contract for the sub-structure of the proposed combination railway and passenger bridge on the St. John Valley Railway in New Brunswick, across the Nerepis River, has been awarded by the Department of Public Works to Messrs. Powers & Brewer. The bridge will be four spans in length, and all the sub-structure is to be of stone and concrete, entailing some work of a difficult character. The contractors are starting work on the sub-structure without delay. Their contract price is between $60,000 and $70,000.

Preliminary construction on the C.N.R. terminal depot at False Creek, Vancouver, is proceeding rapidly. Piling for the foundation is being driven, and concrete foundations will be laid as soon as sufficient piling is installed. Reinforcing steel for the concrete work is now on the job, and local granite, which will form a base course 15 or 16 ft. high, is also cut and on the works. Satisfactory headway is being made, and it is expected that the freight sheds will be completed according to contract by June and the depot proper by the end of the present year.

Active work on the construction of the proposed extension to the Canadian Pacific Railway Company's Pier "D," at the foot of Granville Street, Vancouver, is to be commenced shortly. The pier will be made about 680 feet longer than it is at present, the estimated cost of construction being $750,000. The work of filling in at the end of the present pier is under way, and three dredges have been employed dumping in the material. When completed the new pier will be used by the trans-Pacific as well as by the coast boats, the liners using the west side and the coast boats the east side.

Plans of the proposed diversion of Columbia Street, New Westminster, B.C., moving the C.P.R. and B.C.E.R. tracks, and constructing the C.N.R. through the city, were recently despatched to Winnipeg for approval of General Manager MacLeod of the C.N.R. This has been necessitated by the fact that it was found necessary for the C.N.R. to give 47 feet off their property for the accommodation of the C.P.R. line to give that company a proper approach. It develops that this work will cost more than was at first estimated, as it will necessitate changing the location of the C.P.R. roundhouse.

The Committee on Roads and Bridges of the Council of Victoria County, Ont., discussed the question of good roads and bridges at a meeting recently held in Lindsay, Ont. Mr. Huber, representing the Ontario Department of Highways, addressed the committee on the question of their good roads system. He stated that the mileage contemplated by the county was somewhat excessive because of labor difficulties and the experience of the county in this work. He advised that they join in the good roads scheme now, in order to keep their main roads in good repair, but not to do construction work until after the war. As the first step, he said, a competent county road superintendent should be appointed. In regard to culverts, he pointed out that plans and specifications of satisfactory structures would be supplied by the government, and an engineer would go down on special occasions free of charge. The county, however, must supply its own bridge engineers.

Mr. Hugh McNair, gas expert, in a report to the Manitoba Provincial Government recently, made reference to possibilities of oil at Holland, stating that an investigation had shown a small outcrop of oil shale, which contained 25 per cent. of crude oil. Although it was not likely that oil would be found there, the government had under consideration the question of drilling one or two wells so as to secure samples for analysis. He also stated that natural gas had been struck at the Rannard farm, near Treherne, the pressure being 30 pounds to the square inch. With reference to the experiments with lignite coal at Souris, Mr. McNair said that a suction pressure semi-bituminous gas plant had been installed there, and the operation so far had been satisfactory. He was satisfied that by the installation of the plant cost of power production could be reduced 50 per cent. and the cost of domestic heating and cooking reduced by 40 per cent. Referring to a trip through Northern Manitoba, Mr. McNair said: "There is every reason to be optimistic about its possibilities, and a proper examination and geological survey of the whole district would undoubtedly help toward the development of its mineral wealth.

Personal

Ross & Macdonald, architects, announce that for the duration of the war their Toronto office address will be 61 Front Street West.

Mr. A. R. McVicar, road engineer, of Brantford Township, has been appointed superintendent of roads for Brant County, Ont., under the county good roads system.

Major James A. DeLancey, of the engineering and surveying firm of Lighthall & DeLancey, Vancouver, has been awarded the Military Cross. He had been thrice promoted for meritorious actions since September, 1915, and was mentioned by General Haig in despatches after the Ypres engagement on June 3rd.

Mr. George H. Dawson, surveyor-general of British Columbia for the past five years, resigned that office at the end of the year, to resume private practice. Mr. Dawson, who has been a resident of Vancouver for over 27 years, was appointed to reorganize the provincial department, and handled it through the big land boom, when the staff of surveyors had to be increased from less than a dozen to over sixty.

Mr. George K. Williams, a mechanical engineer well known throughout British Columbia, is now at Chuquicamata, Peru, on a special mission for the Guggenheims, who own there the largest copper mine in the world, with enough ore already blocked out, it is said, to assure active operations for a period of fifty years. Mr. Williams superintended the erection of the Crofton and Ladysmith smelters on Vancouver Island years ago, and had charge of the British Columbia Copper Company's plant at Greenwood for three and a half years, followiing which he engaged in consulting work in Vancouver.

Obituary

Mr. Celestine Blonde, a mason and plaster contractor of Chatham, Ont., died recently in that city, following an attack of pneumonia.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **February 21, 1917** **No. 8**

Principal Contents

	Page
Editorial	153
Detailed Analysis of Peterboro Fire	155
Building Conditions Shown by Permits	162
An Improved Type of Trickling Filter	163
Galt's New Public School	165
Specifications for Concrete Floors	167
Practical Hints for the Contractor	169
Letter to the Editor	170
Mainly Constructional	170

Preparing for Peace Opportunities

IT is particularly gratifying to note the organization that is taking place in Canada to mobilize our human and material resources for a better prosecution of the war. Late as we may have been to realize the seriousness of the situation, and however delinquent our efforts may have appeared, it can, at least, be said that our endeavors are increasing, and that we are daily endeavoring to so comport ourselves as befits us for the task that has been thrust upon us. From our point of view, it is particularly gratifying to observe that the engineers of Canada are, almost to a man, placing themselves at the disposal of the governmental authorities, prepared to undertake any work in their line that they may be called upon to perform. The favor with which such schemes as the Joint Committees of Technical Organizations have been met in the various provinces offers ample testimony that Canadian technically-trained men are prepared to accept any opportunity for patriotic service. And that there is such need for patriotic service needs no argument. Many are the problems before civil and military authorities that require expert and technical advice, a solution of which can most readily be obtained when the men who can solve them are at the state's service.

* * *

This is but one particular example of the work of organization and mobilization and preparedness that might be performed. The statement that the war must be won at all costs is true enough, but that is not all. The war will end, whether in one month or fifty months, and the prospect then, if we do not prepare for it now, will not be a happy one. It is a grim spectre of very substantial proportions which no man can afford to ignore. We have frequently heard of the demoralization and paralysis that will make problems more difficult than those the war has produced, but little progress has as yet been made to prepare for these. All efforts seem to have been expended on seeing the war through first, without giving much thought to the aftermath.

Many of these conditions will have to be met by an economic rather than an engineering solution. There is one matter in particular that will require all our skill and which will offer a wide field for all our resources and abilities. At the close of the war, and perhaps even before it, vast construction and reconstruction work will be demanded in the territories devastated by the war. This will be one of the first matters to be adjusted after cessation of hostilities, and yet, so far, very little preparation has been made to meet these circumstances. The people in the United States are talking about the share they will have in this work of rebuilding, but surely the Allies will attend, as much as possible, to these little matters among themselves, and Canada should have a considerable part to play. Canadian plant, methods, designs, and execution will have wide opportunity in this work. However, though there is this scope for the exercise of Canadian skill and the use of Canadian material, no firm and no contractor seems to have been willing to stake very much, as yet, upon formulating a scheme to make use of his resources. So urgent will be the need of steel, concrete, wood, glass, sewers, pipes, etc., and the fabrication and erection of these, that every contractor who wishes to share in its activities and rewards should lose no time in forming connections, surveying the ground, and preparing plant for such work as he wishes to execute.

* * *

The opportunities here offered are chiefly open to experienced contractors who are able to command considerable capital. Large amounts of money will be needed, and the capitalists must be interested. The smaller contractors will probably have as big an opening by executing sub-contracts, while they will be left to continue the smaller delayed works of this country, while the larger concerns are operating in Europe. If contractors and builders wish to participate in this business now is the time to organize—not when it is too late and the opportunity has been taken up by other interests. Preparation now will be half the battle, and by making due readiness at the present there will be for Canadian contractors steady and vigorous construction operations, with permanent business and reliable profits.

Steel Development Needed at the Coast

THE rapid extension of British Columbia manufactures is bringing into greater prominence the sore handicap imposed as a result of the steel industry being as yet undeveloped, despite the fact that immense supplies of iron ore exist at many points along the coast, as well as in the interior. Several attempts have been made to initiate the industry in a small way, but what is required is a smelter company, with sufficient capital to undertake the manufacture of steel products that now have to be imported at heavy expense. Such an industry would be able to supply raw material for many allied industries and lead to Eastern firms establishing branch factories at Vancouver and Victoria.

At a recent meeting of Victoria Board of Trade the steel question was taken up by David Milne, manager of the Aetna Iron and Steel Company, which is establishing a small plant at the capital. Mr. Milne said:

"If British Columbia can, by building up the smelting of scrap iron, lay the foundation for manufacturing from pig iron, she will establish for herself a permanent industry that will bring to her untold wealth. At present there is an enormous demand for steel to make shells, and if we only had our vast resources of iron properly utilized, we would have steel enough to handle so many contracts in Victoria that half our men and women would be working in munition factories. The reason we have not got the orders is a perfectly natural one, for the British Government must practice economy in the buying of ammunition as much as it must in every other work. The shells manufactured here are made from iron that is sent here from the East. With the high rates of transportation, it is only natural that British Columbia cannot fairly compete with the manufacturers of the East, who have the iron at their doors. The British Government is not to blame. It is simply a question of commerce, not of patronage."

Mr. Milne stated that pecuniary aid from the government was essential if the steel industry was to be established on the coast to the extent that it warranted. He said that as far back as 1780 a man named Humphrey was given a few hundred dollars by the American Government to examine into the resources of the country where he lived. The result of his investigations brought to the attention of the world the tremendous wealth of Pennsylvania—the greatest steel-producing country in the world. The development of the Pennsylvania mines was an instance of where a country properly realized its heritage.

New Brunswick's Revised Highway Policy

IN a recent announcement to the people of New Brunswick, Hon. B. F. Smith, Provincial Minister of Public Works, outlined the new highway policy of the government. Referring to the demand for good roads in New Brunswick, the Minister stated that on the one hand the people of the province had been anxious for greater expenditures, while sufficient funds had not been forthcoming to meet the requirements. In order to overcome this difficulty it is proposed to place the automobile fees, which it is estimated during the year 1917 will amount to $50,000, in a separate fund for the purpose of providing a bond issue that will be made, and which will be retired, both principal and interest, by the fees from automobiles. This bond issue would be slightly in excess of $500,000. To provide adequate supervision and inspection of all road construction and maintenance it had been decided to appoint an inspector of highways in each municipality throughout the province. As to the type of road construction, it was pointed out that the province could not afford to carry out work that would be excessive in cost, but the main ideas of the system would be: The widening of the roads to a uniform width as far as practicable; the proper drainage and crowning of the roadway; the installation of concrete culverts to replace the old wooden ones; and the graveling of highways generally, together with rock filling, and surfacing where it is found that the ordinary earth will not make a sufficient roadbed to endure. Efficient maintenance would be a feature of the new policy, and to meet this need the establishment of a patrol system was decided upon. This system would extend throughout the province, and the patrol men would be furnished with motor power to enable them to transport gravel and make temporary repairs if necessary; also with split-log drags for the dragging of the roads in their respective sections.

Estimated Federal Expenditures

THE total expenditure by the Dominion Government for the fiscal year ending March 31, 1918, is estimated at $203,472,765, a decrease of $67,542,779 as compared with the estimates for the current year. The chief decreases are eleven millions in public works and twenty-three millions in railways and canals, while the chief increases are the interest on the public debt, which is estimated at over eighteen million dollars, and over five millions increase in pensions, making the total in pensions over eight and a half million. However, when the supplementary estimates are brought down, the decrease in the expenditure may be materially lessened. The distribution of the appropriation for the railways and canals department is as follows: Hudson Bay Railway construction, terminals and elevator, $3,000,000; Quebec Bridge, $1,600,000; government railways, $6,875,000; National Transcontinental railways, $500,000; Welland Canal, $200,000; Trent Canal, $600,000; provision of report on the railway situation of Canada, $120,000. The following are the figures for other public works: Parliament building restoration, $2,000,000; Toronto harbor improvements, $1,000,000; Port Arthur and Fort William harbor improvements, $750,000; Toronto postal station A, $500,000; Bowmanville pier repairs, $10,000; Kingston harbor improvements, $52,000; Port Burwell pier repairs, $36,000; Port Stanley harbor improvements, $96,000; Georgian Bay Canal Commission, $25,000; $120,000 for repairs to buildings in Toronto. The sum of $452,715 is also to be voted for the construction and completion of a dredging plant for the St. Lawrence ship canal.

Cutting off piles in the dry below water level was recently effected by means of a movable cofferdam of a riveted steel cylinder 6 feet diameter and 10 feet long, which was lowered around the pile to rest on the bottom of the river. The cylinder was sealed by sand and gravel deposited outside, and was unwatered by a pulsometer. Men then entered the cylinder and cut the pile at the exact elevation with an ordinary crosscut saw. The cylinder was easily shifted from pile to pile, and thus obviated the use of the floating pile driver with a submerged circular saw mounted on a vertical shaft such as is ordinarily used on construction work.

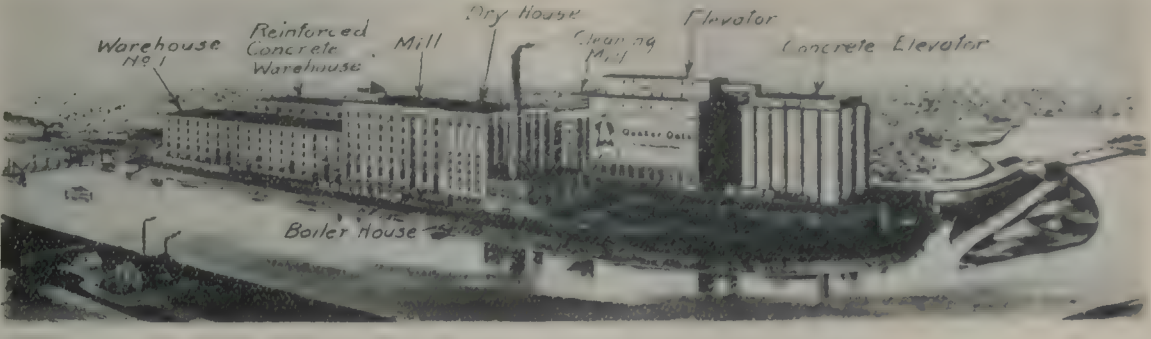

Fig. 1. Perspective view of plant, showing location of the various units.

Detailed Analysis of Peterboro Fire

Most Intense and Longest Sustained Heat on Record—Bricks Ran Like Molasses—Metal Machinery a Molten Mass—Concrete Completely Dehydrated

Editor, Contract Record:

Dear Sir,—In compliance with your request I beg to hand you herewith a report on the recent fire at the Quaker Oats building in Peterborough, Ontario, also copies of photographs which, I believe, in conjunction with the report, will explain the fire very well.

In my opinion it would be impossible at the present time to erect any building that could resist a fire of the magnitude and duration to which this building was subjected. The building was apparently constructed in what is known as the four-way reinforced concrete type of construction. It will be noted that on the first floors there were no drop panels at the columns and also that there was more steel put in the diagonal strip than was put in the straight or direct strip. This is not in accordance with the more recent by-laws, which usually put more steel in the direct and less in the diagonal. Judging from the report, however, the building apparently stood up under quite severe loading and due to the fact that the different by-laws covering this type of construction vary as much as 100 per cent., it seems out of order at the present time to pass any criticism on the way this building was designed.

Yours truly,
W. W. Pearse,
City Architect and Supt. of Building

* * *

Toronto, February 12, 1917.

W. W. Pearse, Esq.,
City Architect and Supt. of Building,
City Hall,
Toronto, Ontario.

Dear Sir,—

I beg herewith to present a report* of my recent trip to Peterboro, Ontario, to study the effects of the fire at the plant of the Quaker Oats Company. In addition to the written report, there are three plates, one table and fifty-two photographs.

Description of Plant

The general layout of the plant previous to the fire is shown in Fig. 1. The fireproof warehouse, in which we are most interested, is given in plan in Fig. 2, the collapsed portion being at the bottom of the figure. Fig. 3 is a typical cross-section of the reinforced concrete warehouse, showing the general constructional features; also reinforcing on the various floors.

The plant, Fig. 1, extends in a general northerly and southerly direction, the left-hand end of this figure being to the south. The view is therefore taken from the north-east. The low building in the foreground is the boiler room, and in the low shed to the north of it was located the fire pump. Next to it on the south is the dry house, identified by the four blank wall panels. Adjoining it, and separated from it by a fire wall, is the mill, and the four-storey building to the south of the mill is a warehouse, which was divided into two sections by another fire wall. Both these buildings are of the type known as "Mill Construction," and were separated by a fire wall. The offices were located on the first floor of the warehouse building at the extreme south end. In the background at the right end of the picture are shown eighteen circular reinforced concrete grain bins, and to the south of these an elevator of wooden crib metal-clad construction. The brick building adjoining the elevator on the south, is the cleaning building, through which the grain was passed on the way over the enclosed bridge to the top storey of the dry house.

The Reinforced Concrete Warehouse

The reinforced concrete warehouse may be seen in Fig. 1, over the roof of the warehouse first mentioned. It was approximately 60 feet wide, 280 feet long, and basement and six storeys high. The first four storeys were built in 1910 and the two upper ones in 1916, and the common practice at these different dates is well represented in the details of construction. The floors were designed for 200 lbs. per square foot, live load, and the structural details are shown in Fig. 3. In the first four storeys there are no drop panels at the top of the columns, and the column caps decrease in diameter with the columns. There is also more steel in the diagonal bands of reinforcement than in the direct bands. The circular reinforcement of the column shafts consists of separate steel hoops about 1[illegible] in. x ¼ in. in section, spaced about 8 inch centres. As the theory of flat slab con-

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* Presented herewith in abstract only

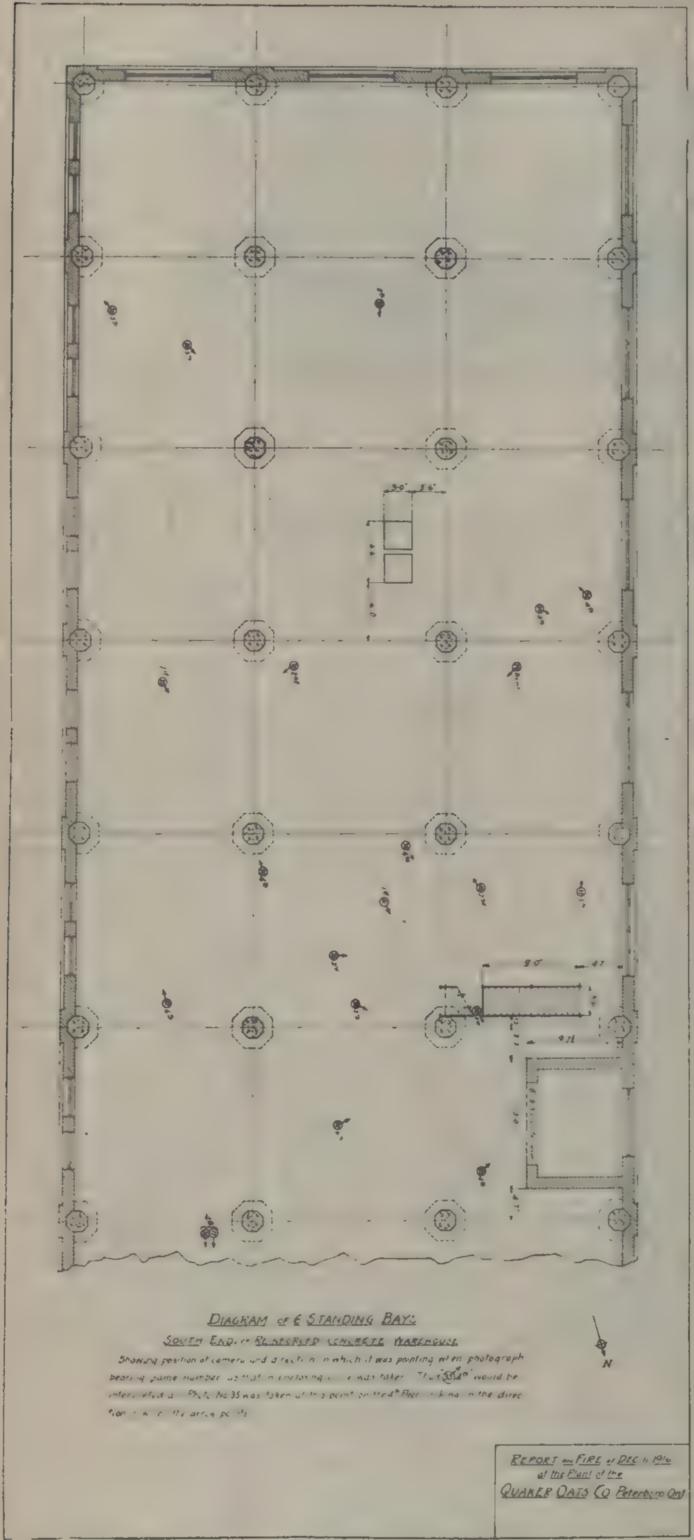


DIAGRAM OF 6 STANDING BAYS
SOUTH END OF REINFORCED CONCRETE WAREHOUSE
N
REPORT ON FIRE OF DEC 11 1916
at the Plant of the
QUAKER OATS CO Peterboro Ont

Fig. 2—Part plan of reinforced concrete warehouse.

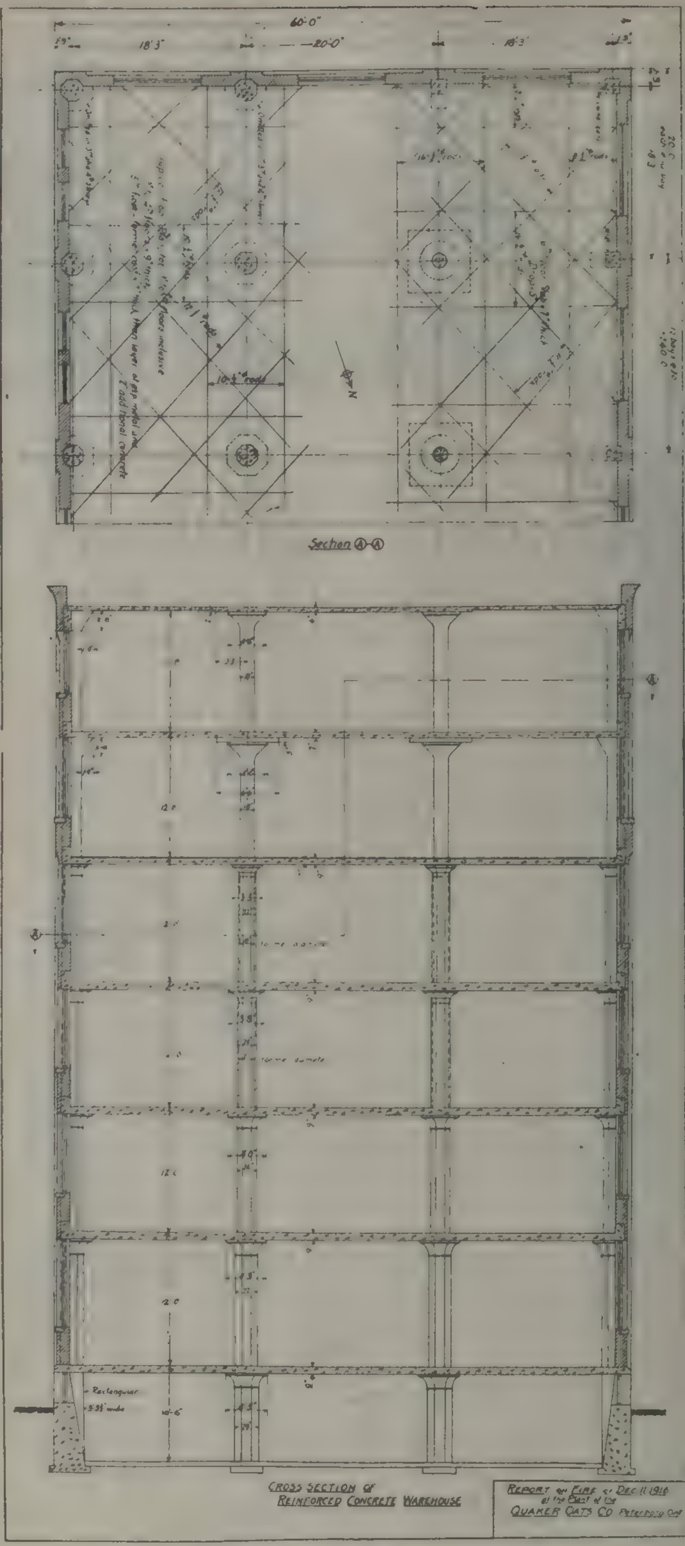

60'-0"
18'3"
20'-0"
18'3"
Section Ⓐ-Ⓐ
N
CROSS SECTION OF
REINFORCED CONCRETE WAREHOUSE
REPORT ON FIRE OF DEC 11 1916
at the Plant of the
QUAKER OATS CO Peterboro Ont

Fig. 3—Cross-section below; horizontal section above.

struction was not understood at the time these storeys were built, these are features that contradict the facts brought out later by extensometer tests, but they represent the best construction known at the time. The upper two floors show the column capital of constant diameter, the drop panel, the correct distribution of the slab steel, and the spiral form of circular column reinforcement. For some reason or other, the drop panels were omitted from around the caps of the wall columns in the two upper storeys and a bracket substituted. On the corner columns even these brackets are lacking. Since a drop panel would not have interfered with the windows, it is hard to tell just why this was done, for at these places the bending moments are most severe. It might have been that the type of construction adopted required less work on the forms. It might be fair to state, however, that up until quite recently another American firm had this bracket system as one of its standards, in which case they used four brackets around the interior columns, and no flaring heads. When the two upper storeys were erected it was decided to increase the diameter of the columns on the third and fourth storeys to aid them in carrying the additional load. This was accomplished by wrapping them in expanded metal and pouring a rich grout around them. The fifth floor—the former roof—was increased from 7 inches to 9 inches in thickness by laying expanded metal upon it and pouring another 2 inches of concrete on it. The aggregate used throughout was a local gravel of good quality. The north wall of the building was blank. The east wall, facing the lane between the reinforced concrete building and warehouse No. 1 had a large number of windows with metal sash and wired glass. The sash and frames in the first four storeys were of hollow metal, and in the upper two storeys were of solid metal. On the other two sides of the building ordinary wooden frames and sash were used, with the exception of the north bay on the west side, which was the same as on the east side. All the buildings with the exception of the concrete warehouse and the concrete grain bins of elevator B were equipped with automatic sprinklers. All the buildings shown in Fig. 1, with the exception of the circular grain bins, are now in ruins. The lower 15 feet of two of the tanks were somewhat spalled and on the easterly of these two tanks one small hole was burned through the wall. As this was below the level of the floor in the bin it did no damage. (Note.—added February 6th. The noon editions of to-day's papers contain the information that fire smouldering along the conveyor belt passages beneath these grain bins caused an explosion which blew the top of one of these bins into the river).

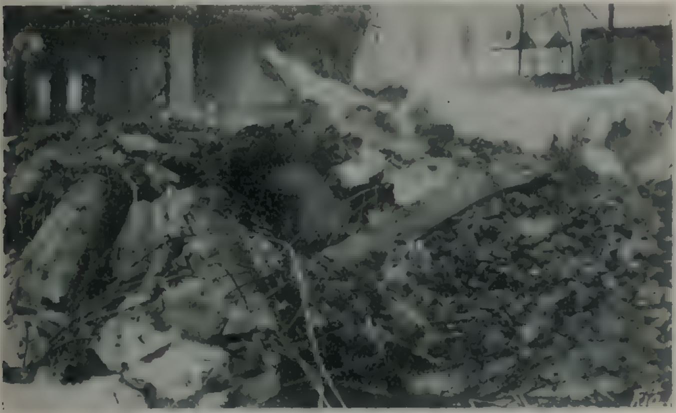


Fig. 4 (18)—Tangled mass of machinery—Numbers in brackets Figs. 4 to 13 correspond to circled numbers in Fig. 2.

The Fire

The fire was started about 10.15 a.m., by an explosion in the Dry House. The exact cause of the explosion has not yet been determined, but is under investigation by Provincial Fire Marshal Heaton. Both the north and east walls of the Dry House were blown out by the intensity of the explosion, and as the plant was in operation and all fire doors open, the mill was filled with fire on all floors at the same time. The fire spread rapidly through the mill, but was kept from breaking into the warehouse for a little while by the wall and by the fire doors which the employees of the Quaker Oats Company, under the direction of Superintendent W. H. Denham, managed to get closed before the fire got that far. There was a fair easterly wind, which drove the flames across the bridge into the Cleaning Building and Elevator A; and when the Mill and Warehouse No. 1 were on fire, subjected the concrete warehouse to a fearful exposure. About 11 a.m. the contents of the reinforced concrete warehouse began to blaze, the fire starting on the third and fourth floors where there were large piles of box shooks. An attempt was made by employees, under Mr. Denham's direction, to close such windows as were open and to get a stream of water on the blaze, and they succeeded in closing all except one of the windows, but could not reach that, because of the fire.

Early in the fire the wired glass in the east face of the warehouse building was hanging in sheets down the wall, and the wooden frame and sash from the south wall were completely gone. It was in the west and middle windows of the second and third floors that cast iron sash weights were found partly fused. The fire raged in the concrete warehouse without one drop of water being poured on it till 6 p.m., when six and two-third bays north of the centre of the building fell.

How the Fire was Fought

In falling, the north wall of the Dry House buried the Boiler Room, and the east wall carried with it a 6-inch sprinkler riser, at the same time burying the valve controlling this riser. The fire in the mill would naturally open up the sprinklers fed by two 6-inch connections in the mill, with the result that with three 6-inch streams drawing from one 8-inch main the pressure was reduced to practically nil. Thus the private fire protection was put out of commission at the very start, and during the early stages of the fire the city system was badly crippled.

Damage to Buildings

The condition of the buildings after the fire may be judged from Fig. 4, which shows the tangled heaps of machinery in the mill, and part of the reinforced concrete warehouse in the background. So intense was the fire that not even one charred stick of wood may be found on the plant. Fig. 5 gives a general view of the remains of the concrete warehouse. Near the left edge of Fig. 4 will be noticed one of the lower storey columns around which may be seen the circular hooping. From the distribution of the debris, it may be concluded that in collapsing the building settled straight downward.

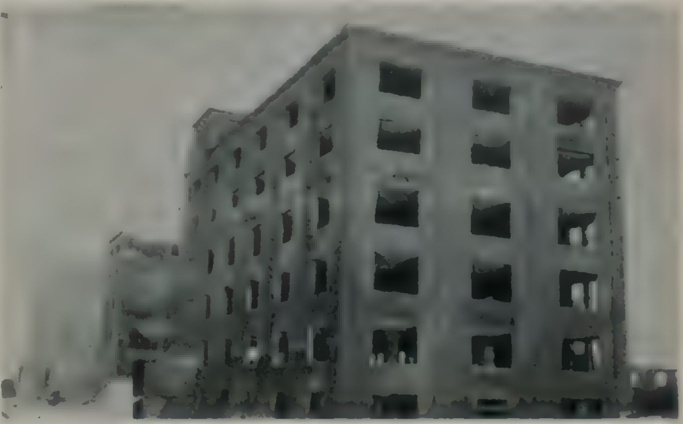


Fig. 5 (15)—Concrete warehouse following the fire.

Temperatures Developed in the Fire

Eloquent testimony as to the temperature developed in the reinforced concrete building is given by the expansion cracks. Owing to the heating of the floors and their consequent expansion, the length of the building considerably increased, and caused peculiar diagonal cracks to appear in the brickwork. At the other end of the building the cracks run diagonally downward in the opposite direction. One curious effect of expansion due to heat was found in the elevator penthouse. The upper end of the elevator guides came to within an inch of the ceiling formed by the penthouse floor slab. Due to expansion, these guides pushed two holes through this slab.

In the foundation wall of the Dry House, the limestone was calcined to a depth of nearly a foot. This is evidence of long continued heat. Fig. 6 shows the effect of the heat radiated from the burning concrete warehouse upon the walls of warehouse No. 1 across a lane 40 feet in width. At many points about the plant freight cars were standing, and all but the metal parts were entirely consumed.

The temperature in the interior of the building in places must have been very intense, for melted metal parts of machines may be found here and there in the ruins. In the front windows of the second storey and in the front and some of the west windows on the third storey of the concrete warehouse were found melted sash weights. In some cases they were but slightly fused, in other cases two or more weights had run together, and in several places on the third floor the weights were reduced to shapeless masses of cast iron. On the inside of the walls of all the buildings may be found large patches of fused brickwork of which Fig. 7 gives an example. This view was taken on the third storey of the reinforced concrete warehouse. The melted brick ran down the face of the wall and out upon the floor like molasses, for a distance of about 18 inches, and over the doorway it trickled across the face of the concrete lintel and dripped from there to the floor. Upon breaking off some of this fused brick from the lintel, it was found that the concrete had been badly calcined beneath the running brickwork. From the fact that cast iron melts at about 2200 degs. F. and that brickwork reaches the stage of incipient fusion at about the same temperature, it must be concluded that at many places during the conflagration, temperatures in the neighborhood of 2300 degs. F. must have been reached.

Effects of the Fire on the Concrete Building

That the concrete building became such a wreck is something that may cast grave doubts upon the fire-resisting qualities of flat slab construction. Six and two-thirds bays out of fourteen have fallen in an almost shapeless heap of debris. The cement in the floors of the parts still standing is dehydrated completely through, and when a block of the floor slab, such as may be seen hanging from the reinforcing rods is detached, it may be broken easily by dropping it on the ground or rapping it against another such block. As may be seen in Figs. 8 and 9, the floor slabs practically everywhere sag somewhat, and in many places are at the point of incipient failure.

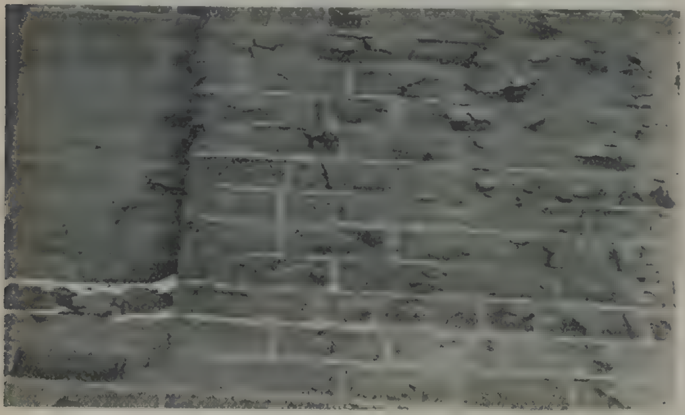


Fig. 6 (24)—Heat effect on bricks across 40 foot lane.

If we consider the effect of heat upon concrete it may shed some light on the subject. Experiments upon the heat conductivity of concrete are rather few, but from those of Professor Ira H. Woolson, reported in the Proc. Am. Soc. Test. Mat., Vol. VII., 1907, p. 408, we learn that, when subjected to a temperature of 1500 degs. F. for two hours, a point 2 inches from the exposed surface of a block of concrete had its temperature raised between 500 degs. F. and 700 degs. F. We learn also that de-hydration of the cement crystals begins about 500 degs. F. and is complete at about 900 degs. F. Thus we may reason that de-hydration has reached a point of 2 inches below the surface of a piece of concrete after being subjected to a temperature of 1500 degs. F. for two hours. In the reinforced concrete warehouse under consideration, we had a temperature that, according to those who saw it, "was like a blast furnace by 1 o'clock," and which at the time of the collapse, at 6 p.m., had lasted five hours. We have seen that it must have reached 2300 degs. F., and that, owing to the great quantity of fuel, must have been maintained practically constantly. The fact that the floor slabs are completely dehydrated is therefore not beyond comprehension, nor does it contradict the evidence of the experiments quoted.

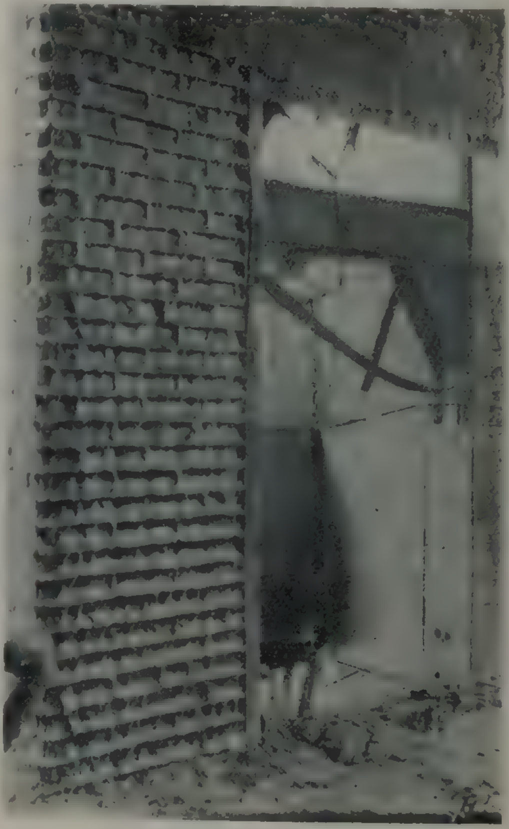


Fig. 7 (28)—Melted brick ran like molasses.

In addition to this, Professor J. B. Johnson, in his "Materials of Construction," states that the working strength of steel decreases with a rise in temperature, and that this decrease takes place at the rate of approximately four per cent. for each 100 degs. F. increase. If we take the evidence of the brick shown in Fig. 7, which shows that a temperature of over 2000 degs. F. penetrated two inches into a material of just about the same conductivity as concrete, and, from this assume that the slab rods reached this temperature, it is evident that their working strength was reduced by about 80 per cent. For steel with an elastic limit of 35,000 lbs. per square inch, this would mean that the available working strength was less than 7,000 lbs. per square inch. In the columns this would not be of such grave importance as in the floor slabs, but in the slabs the stresses developed were in excess of this reduced allowable stress, as will be shown later. It is therefore probable that owing both to the weakening of the concrete in compression and the steel in tension, the floors failed first and carried the columns with them. Whether any other type of construction would have stood the fire better is, of course, a matter of conjecture.

Details of Damage to Concrete Building

As mentioned above, blocks of the concrete may be readily broken. At a depth of about an inch the aggregate thus exposed shows no noticeable effect, unless it be of some coarsely crystalline structure such as granite. One such piece of granite as big as a man's fist was easily crushed by the grip of one hand. Closer to the surface the aggregate calcined. The surfaces, being directly in contact with the fire, were everywhere calcined from ¼ in. to ½ in., and on those blocks which fell into the fire in the collapsed portion calcination is practically complete. At no point is there any evidence of fusion of the aggregate in the concrete. Particular care was exercised in verifying this fact, for in the fire at the Edison Phonograph Works at West Orange, N.J., in 1914, such fusion occurred. At first glance the material hanging from the cracks in the ceiling shown in Fig. 8 might be taken for fused concrete, but chemical analysis makes it practically certain that this is phosphatic material from Quaker Oats, which was piled in cases on the floor above. In the exact centre of Fig. 4 the head of one of the basement columns may be seen, and it looks as though fusion had occurred at this point. It was largely for the purpose of determining whether or not this was fused concrete that occasioned my second visit to the plant in Peterboro, and I found that conditions had changed considerably since Fig. 4 was photographed. No fusion was evident, but the large calcined masses are rapidly air slaking. This slaking process had already started at the time of my January visit.

Separation of Wearing Surface from Slab

All floors had been given a 1-in. wearing surface, and practically everywhere throughout the standing portion of the building this 1-inch surface has left the main slab. Although the wearing surface did not leave the floor slabs so noticeably under the box shooks, it is nevertheless calcined, and can be readily separated from the rest of the floor by tapping with a hammer. Professor Woolson has often stated the opinion that gravel aggregate reduces the fire resisting properties of concrete, although his references are chiefly to quartz gravel. There is in this fire much to cause doubts as to the correctness of this opinion. In a number of cases the aggregate can be seen exposed. In the third storey this condition prevails over practically the entire ceiling, and patches of the remaining smooth surface are constantly dropping off. It would seem perhaps more correct, in the case of this building at least, to attribute this appearance to the calcination of the cement and gravel at the surface which allowed it to fall of its own weight. In the case of the deeply affected part of the slab around the column head in the foreground of Fig. 10, the result is more than likely due to the excessive compressive stress that existed in this locality. Exposed corners on horizontal surfaces suffered everywhere, as see Fig. 12.

The reinforcing rods even though protected in some cases with a very thin coat of concrete were not oxidized until exposed. This might have been inferred from the fact that a thin coat of cement mortar will prevent rust, which is somewhat analagous to the black oxide formed on metal when subjected to fire; and wherever a slab failure occurred the broken ends of the rods were drawn down as in any typical tension failure.

Damage to Columns

That the shape of columns has something to do with the damage they sustain is shown in Figs. 9 and 11, although with the exception of the two in the background of Fig. 9, the square ones appear not to be badly affected. But the appearance of all the columns shown is very deceptive, except, perhaps, those of Fig. 11, which are not so bad, being in a part of the basement where there was less combustible material. The dehydration spoken of before has affected the columns as well as the slabs, and extends to well inside the circular hooping. A month ago this was scarcely apparent. The weather in the meantime has caused the appearance of the concrete to change. A month ago a freshly fractured piece of dehydrated concrete could scarcely be distinguished from a good piece, but the weakness is now apparent, the mortar amongst the aggregate having more the appearance of dried blue clay. It is altogether possible that the hooping on the columns is largely responsible for their not failing. Fig. 12 shows the partial failure of a column due to the spiral hooping not enclosing sufficient of the concrete, and offers partial support to the statement just made. On all columns a few light blows with a hammer will detach large pieces of the concrete outside the hooping.

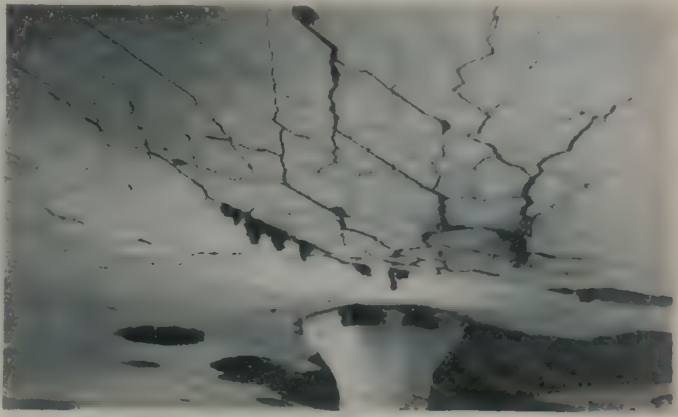


Fig. 8 (33)—Floor slab cracked and sagging.

In heaps of combustible material burning on the outside, gases would be formed within the pile and slight explosions might thus occur. The fact that they did occur is evidenced by Fig. 13, which shows a portion of the fifth floor from below. None of the material which came from this destroyed portion of the floor could be found on the fourth floor, but, was lifted up and deposited around the opening. This is evidence of a slight explosion from below. Beneath the first floor there were one or two similar puffs. The fact that there could not have been any explosion of magnitude may be drawn from a consideration of several of the photos, which show that the building apparently settled straight downward. Other instances were noted of a number of columns, which apparently dropped directly down.

Effect of Fire Doors and Wired Glass

As to some of the details of construction, the solid metal fire doors stood the heat much better than the wood tin-clad doors when subjected to about the same heat condition. The trap doors in the stairway are complete ruins. From this we may reach the conclusion that the solid metal fire doors offer a more effective resistance to fire than do the wood tin-clad ones, and also that trap doors can never take the place of a proper stair enclosure.

Early in the fire the wired glass was completely gone, and may be found hanging in sheets down the outside of the walls, or running down the brick inside as noted at several points. It must have kept the fire out of the concrete warehouse a little while, for the first fire to gain admittance did so through an open window near the north end of the building; but as to resisting severe exposures, its value is not great. It is possible that iron shutters, if they had been in working order, would have afforded much better protection; for even if they were not of the automatic closing type, the employees had time enough to close them by hand, as they did the openings in the wired glass windows. The metal window sash and frames, both hollow and solid, withstood the heat very well. The wooden frames were, of course, quickly consumed and the plain glass was worthless.

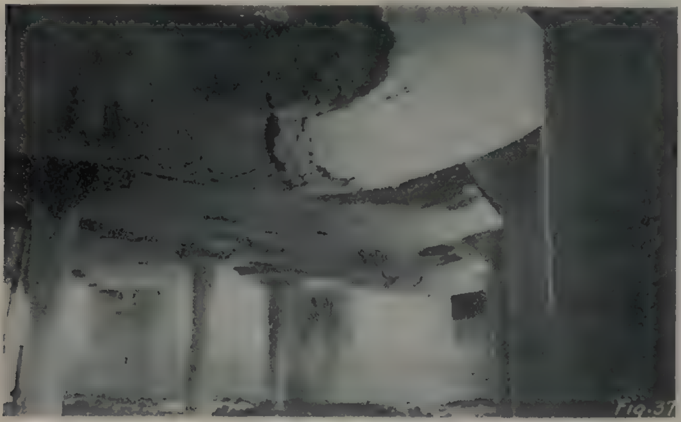


Fig. 9 (37)—Floor slabs sagging.

Effect of Design and Loading on Failure

The permissible load on the first four floors varies greatly, depending upon the governing conditions. The diagonal bands have an excessive strength and the straight bands are somewhat deficient in steel, but the weakest point in the design is in the column head areas. Owing to the fact that the slab is the same thickness throughout the resisting moment of both steel and concrete over the column head is quite inadequate for the design load. This is more apparent in the wall panels than in the interior panels, and the effect is probably heightened owing to the fact that the building it but three panels wide. As these four floors were built before the laws governing flat slabs had been investigated to any extent, this need not be regarded as a reflection on the designer, for the class of work was excellent. The fifth floor, owing to its increase in thickness, and the method by which this was accomplished, does not lend itself to computation. The sixth floor and roof represent the most modern methods of flat slab construction, with the exception of the fact that no drop heads were provided around the wall column caps where they were probably most needed, and the brackets provided on the columns were in no way reinforced. For shear, these brackets were sufficient, but they were very lacking in providing resistance to bending moments. Other than this, the class of work on the two upper storeys was good.

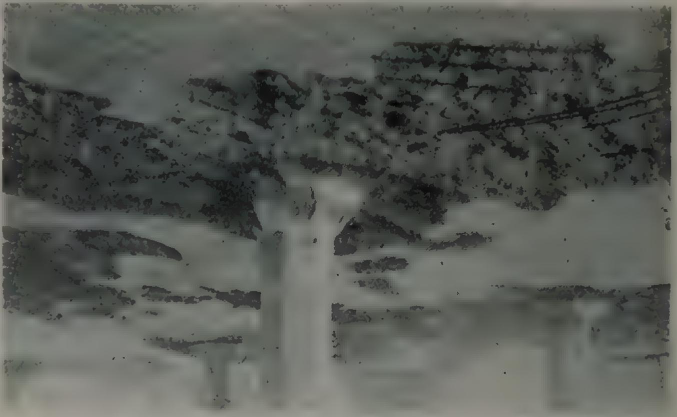


Fig. 10 (34)—Failure due to excessive compressive stress.

From the location of the elevator shaft, the workmen found it very much easier to begin their loading from the north end of the building, and to fill both side aisles, reserving a trucking space down the centre of the building. This method of procedure naturally put the bulk of the load on the side panels where the structure was least able to carry it.

Conclusion

The first lesson to be drawn from this conflagration is that absolutely "fireproof" construction is a chimera, for if heat is sufficiently intense and long enduring, no material can withstand it. This fact has been demonstrated in fires upon practically all the materials of "fireproof" construction, and now the latest type of building succumbs to it. The fact that concrete stood so well in the Edison fire has been hailed far and wide, and the severity of that fire was so great that it has become somewhat of a criterion of fire intensity. It seems almost sacrilege to say that at the Quaker Oats fire we had a more severe fire than at the Edison plant. Yet in the press of the time cuts are printed which show that not one of the large concrete buildings of the Edison plant had all the floors in full blaze at the same time. Nor did the fire remain in full intensity for more than an hour or two

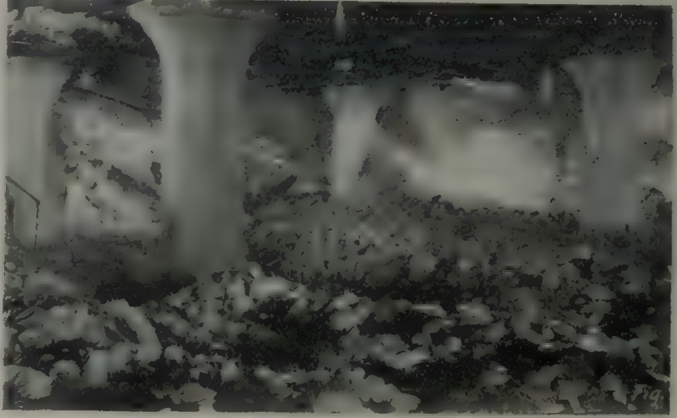
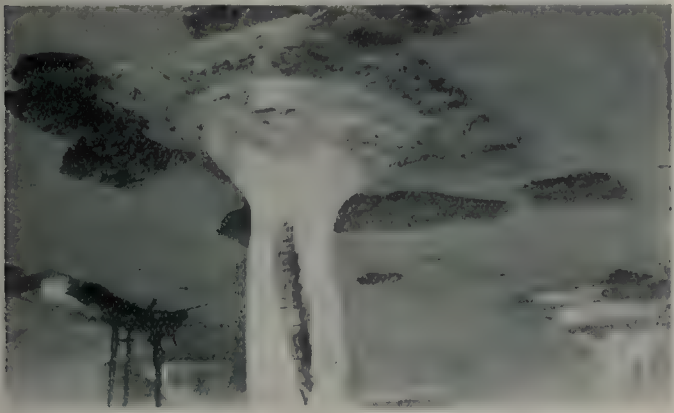


Fig. 11 (41)—Shape of column affects amount of damage.

at any one place. Neither are there more abundant proofs of intense heat. But in the reinforced concrete warehouse at the Quaker Oats plant a fire occurred upon all the floors at the same time, of an intensity at least equal to that developed in the Edison fire, and it was seven hours after the fire started before collapse occurred. Even after two months there is considerable heat in the debris, and in some places there is fire still. It is not to be considered to the discredit of flat slab construction that a building of this type failed under such extraordinary circumstances. There was no fusion of the concrete, but the fusion evident at the Edison fire may have been due to the nature of the combustible materials at the points where this occurred.



Fgl. 12 (30) – Failure due to defective reinforcing.

Another point emphasized again is that hazardous features should be isolated, preferably in buildings with large window areas. In this case the large blank wall areas of the Dry House tended to hold the pressure. Consequently not only were the walls wrecked, but the fire was flung far into the mill. In several small explosions in Toronto wired glass has had the effect of holding the pressure, with consequent damage to walls, so the window areas recommended should preferably be glazed with plain glass.

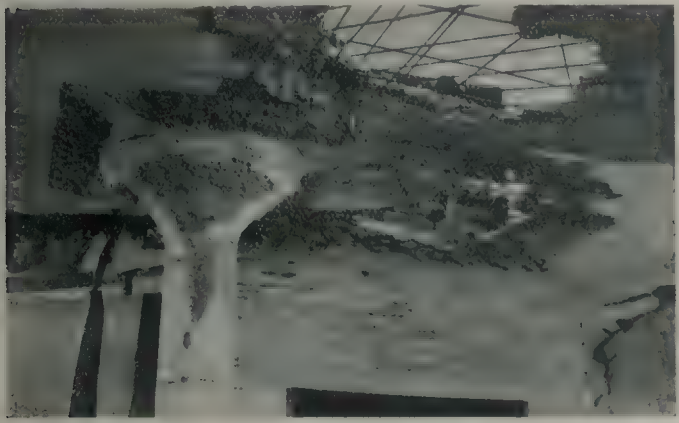


Fig. 13 (39)—Evidences of slight explosions – Floor material from this opening found on upper floor.

As far as the matter of fireproofing is concerned, if a fire is of sufficient intensity to heat a nine-inch floor slab through, it is evident that four and one-half inches of fireproofing would avail nothing. Moreover, if it is merely covered with mortar the reinforcing will not oxidize. In the usual design of flat slab, the steel is not stressed to more than about one-third of its elastic limit under design load, so it could readily stand a temporary reduction in strength of fifty per cent. This would correspond to a rise in temperature of about 1250 degs. F., at which temperature the cement in the concrete would be completely dehydrated. There is nothing to be gained, therefore, by excessive fireproofing of the rods.

Respectfully submitted,
T. D. Mylrea,
Engineer in Charge of Tests

Outside Advice on Montreal Aqueduct Scheme

The appointment of Mr. Arthur H. St. Laurent, assistant deputy minister of public works; Mr. H. E. Vautelet, former chairman of the Quebec Bridge Commission, and Mr. J. B. McRae, consulting engineer, Ottawa, to examine and report on the Montreal aqueduct, particularly in relation to the proposed hydroelectric development, is at least a partial justification of the action of the Council of the Canadian Society of Civil Engineers and the ratepaying engineers. The reports of the latter and of Mr. P. Mercier, the chief engineer of Montreal, are in direct contradiction as to the cost, economic value, and possibilities of the scheme, and while Mr. Mercier recommended that the scheme be immediately proceeded with, he also suggested that the city should obtain the advice of three independent experts. The ratepaying engineers insisted that it was imperative that an independent board of engineers should be appointed, and the Council, by voting $5,000 for the fees of the experts named, have agreed that a comprehensive examination of the plans is advisable, without, of course, admitting that the criticisms are justified. Mr. Vautelet and Mr. J. B. McRae are members of the Canadian Society of Civil Engineers, but have taken no part in the controversy. It may be that the report will be a complete vindication of the scheme, but in view of the opinion of the ratepaying engineers, many of them of the first rank in electrical engineering, it is in the best interest of the city that an outside opinion should be obtained before expending several additional millions of dollars.

Forty Per Cent of British Columbia Surveyors Serving at the Front

At the annual general meeting of the Corporation of British Columbia Land Surveyors, held at Victoria recently, the statement was made that about 40 per cent. of the surveyors of the province are now on active service, as well as a large number of their former pupils and assistants. It was unanimously decided to extend assistance from the funds of the corporation (where necessary) to members who are serving with the forces or their dependents. The following officers were elected for 1917: Prsident, N. F. Townsend, Vancouver; vice-president, S. S. McDiarmid, Vancouver; secretary-treasurer, W. S. Gore, Victoria; board of management, Messrs. O. B. N. Wilkie, F. C. Green, W. S. Drewry, John Elliott, and E. B. Hermon.

The hoisting speed of a winding engine drum is found by multiplying the revolutions of the crank shaft per minute by the number of teeth in its pinion and by the circumference in feet of the drum and dividing the results by the number of teeth in the drum gear, which gives the hoisting speed in feet per minute of a single line wound on the drum.

Building Conditions as Shown by Permits

IN the adjoining curves is shown the variation in the value of building permits issued in the Dominion of Canada during the years 1908 to 1916 inclusive, the fluctuation being indicated for each province as well as for the country as a whole. The curves have been obtained from the values of the permits issued for 53 cities and towns in Canada. As indicated by the graph, the building conditions in Canada showed rapid and constant improvement from 1908 to 1912, the total value of permits issued in 1912 being more than 4½ times as great as their value in 1908. The year 1912 was the bumper year, for during this period the value of buildings erected reached the highest total in Canada's history. Since then it has declined, and although showing a tendency to recover during the last year, it is still very far below 1912's record total. The boom that had gradually enveloped Canada reached its highest pitch in 1912, so that building depression began before the war and cannot be entirely traced to it. Canada's condition, so far as construction is concerned, reached a low-water mark in 1915, when the value of permits hardly reached the total of 1908. The war evidently had its effect, for it reduced the value of buildings erected from $104,644,437 in 1914 to $36,100,838 in 1915, largely on account of the uncertainty or lack of confidence that existed. The year 1915 was, however, a turning point, for during 1916 the permits were 18 per cent. greater than in 1915. The first effects of war had apparently dissolved, leaving people readier and more willing to continue the postponed building of the previous years. As frequently pointed out, the building activity in Canada during 1916 was nothing to be pessimistic over.

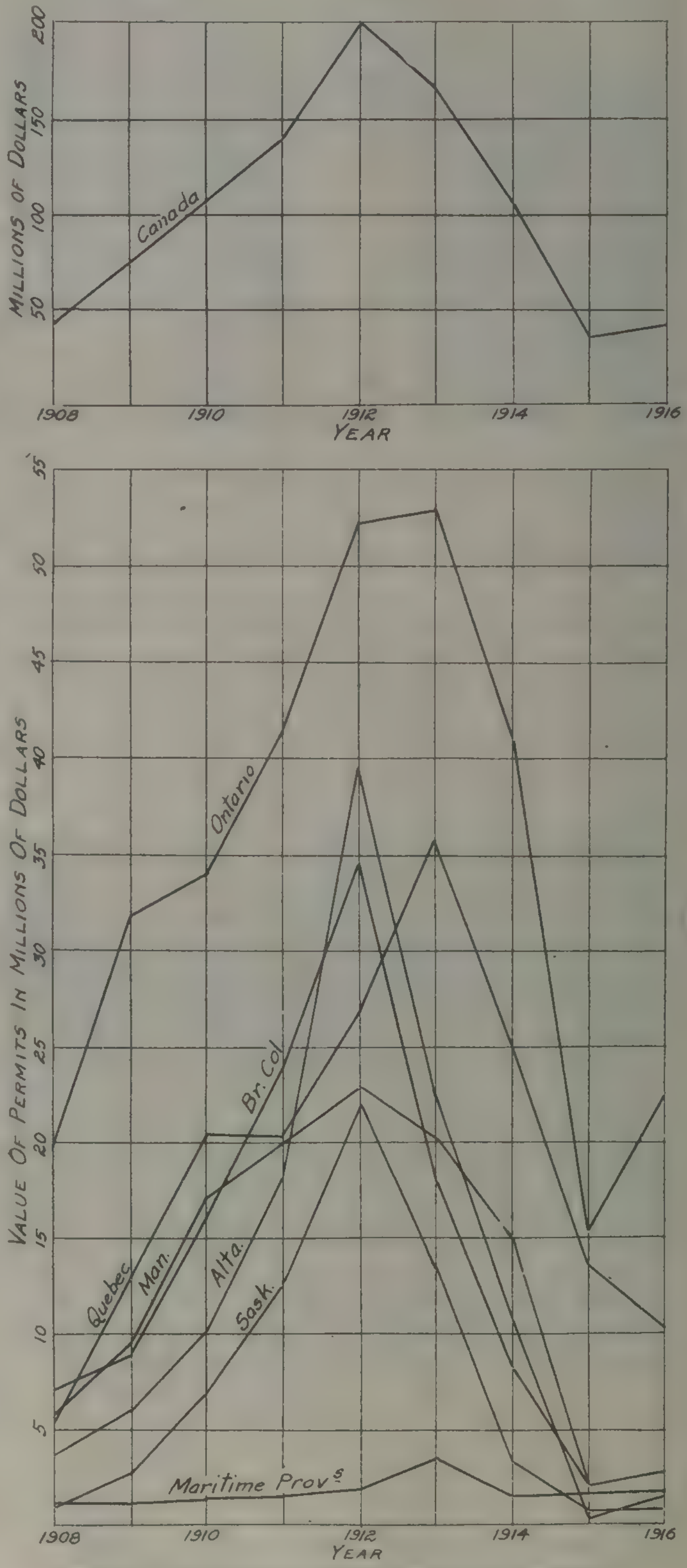
Provincial Conditions

Investigating the building conditions by provinces, the curves appear to divide themselves into two distinct groups. The curves for Manitoba, Saskatchewan, Alberta and British Columbia, have their peaks in the year 1912, while the highest pitch in the eastern provinces occurred in 1913, one year later. This serves to indicate that the slumps are evident earlier in the West, while conditions being much stabler in the East, declines are not as rapid. The low values to which western permits fell in 1915, as compared with those of eastern provinces, further indicates the more uncertain conditions in the West. For example, Alberta, which of all the western provinces showed the most prosperous condition in 1912, fell to the lowest point of any province in Canada in 1915.

The provinces individually show improved building activity in 1916, with the sole exception of Quebec, which registers a decrease. The Maritime Provinces are consistently steady, and although showing a considerable increase in 1912, the remaining years are fairly uniform. These provinces are the only ones showing a rise in the permit value of 1915 over that of 1914. Ontario stands above all other provinces in the values of buildings erected, those in 1916 more than equalling the total value of buildings constructed throughout the rest of the Dominion.

Not an Absolute Indication

It must be understood that these figures apply to buildings erected in cities only, and do not include those built in rural districts or in suburbs just outside city limits. Many hundreds of thousands of dollars' worth have been constructed just outside city limits where land is cheap and taxes low. This applies very largely to munition plants and the value of such buildings has not been included nor shown in the



Variation in the value of building permits issued by fifty-three Canadian cities and towns.

curves, and hence these figures must not be considered as an absolute indication of Canada's total building situation. This condition, we believe, is particularly true of Montreal, and similar conditions in other cities may account for the apparent decline in the permits of Quebec during 1916.

In the following table are given the comparative building permits in 53 cities of Canada for the years 1915 and 1916:—

Comparative Building Permits for 1916 and 1915

	1916	1915		Change
Maritime Provinces,—				
Halifax	$1,226,329	$1,063,985	+	$ 162,244
St. John	464,350	346,275	+	118,075
Sydney	128,105	199,902	—	71,797
Quebec,—				
Maisonneuve	180,345	776,200		595,855
Montreal	5,334,184	8,511,221	—	3,177,037
Outremont	453,038	389,430	+	63,608
Quebec	2,913,157	2,578,042	+	335,115
Three Rivers	537,345	484,215	+	53,130
Westmount	545,754	589,405	—	43,651
Sherbrooke	425,000	354,000	+	71,000
Ontario,—				
Brantford	282,677	235,600	+	47,077
Brockville	170,420	46,010	+	124,410
Chatham	1,338,924	247,710	+	1,091,214
Fort William	414,025	639,730	—	225,705
Galt	253,795	140,140	+	113,655
Guelph	155,222	219,672	—	64,450
Hamilton	2,405,781	1,532,248	+	873,533
Kingston	184,321	244,088	—	59,767
Kitchener	324,838	329,990	—	5,152
London	926,125	1,207,630	—	281,505
North Bay	15,870	121,228	—	105,358
Ottawa	1,530,400	1,605,160	—	74,760
Peterboro	127,975	98,610	+	29,365
Port Arthur	1,565,095	83,825	+	1,481,270
Preston	36,850	46,575	—	9,725
St. Catharines	616,515	446,121	+	170,394
St. Thomas . .	141,165	134,485	+	6,680
Stratford	190,619	210,155	—	19,536
Sudbury	165,500	103,515	+	61,985
Toronto	9,881,671	6,651,889	+	3,229,782
Welland	202,587	191,232	+	11,355
Windsor	1,508,330	720,870	+	787,460
Woodstock	88,806	86,021	+	2,785
Manitoba,—				
Brandon	246,748	36,155	+	210,593
St Boniface	135,392	213,260	—	77,868
Winnipeg	2,507,300	1,826,300	+	681,000
Saskatchewan,—				
Moose Jaw	318,945	90,772	+	228,173
Prince Albert	66,330	30,003	+	36,327
Regina	222,075	465,065	—	242,990
Saskatoon	146,150	20,200	+	125,950
Yorkton	35,675	48,385	—	12,710
Alberta,—				
Calgary	663,500	150,550	+	512,950
Edmonton	213,940	301,725	—	87,785
Lethbridge	84,122	58,420	+	25,702
Medicine Hat	410,000	56,840	+	353,160
Red Deer	29,180	17,735	+	11,445
British Columbia,—				
Nanaimo	14,606	50,582	—	35,976
New Westminster ..	85,307	85,130	+	177
Prince Rupert	28,300	33,700	—	5,400
South Vancouver ..	98,602	107,475	—	8,873
Vancouver	2,412,889	1,593,279	+	819,610
Vernon	17,880	7,330	+	10,550
Victoria	170,265	292,450	—	122,185
Total	$42,642,324	$36,120,535		$6,521,789

An Improved Type of Trickling Filter

Lath, Pole and Brush Filters, Providing Greater Surface and Allowing Freer Air Circulation, Give Excellent Results.

By Lt.-Col. G. G. Nasmith, C. M. G., Ph. D.[*]

THE object of every method of sewage disposal is to resolve the complicated putrescible organic materials present into simpler, largely inorganic, compounds which are no longer decomposable and incapable of causing offence; in other words, it is to create a harmless and non-putrescible effluent. Such an effluent is commonly said to be "purified."

Methods such as that of the septic tank fail, because, working in the absence of oxygen, they only partially split organic material, and these products of hydrolytic action have still to undergo further destructive processes in the presence of oxygen before they became stable.

Sewage disposal, in the ordinary sense of the term, resolves itself in chemical terms to the formula: Organic matter + oxygen = inorganic matter + humus (a stable organic material).

The aim of every method of sewage disposal has been to take advantage of the oxydizing properties of living micro-organisms. Methods which have failed are those which have not provided the necessary conditions—that is, a sufficiently large mass of aerobic micro-organisms, properly harnessed to work in the presence of an abundant supply of air.

Without going into detail, it has been established beyond question that the only methods of sewage treatment which fulfill the above conditions are the trickling filter and the more recent activated sludge method.

The trickling filter requires specially prepared bacteria beds, several feet in depth, made of stone, slag, coke, or other resistant material, as a nidus for the bacterial growth. Sewage, when sprinkled or sprayed over the surfaces of such beds, slowly trickles over the pieces of stone until it finally reaches the bottom. In the course of a few weeks the pieces of stone become coated with a pellicle of slime, which has been shown to consist principally of bacteria and protozoa. It is this living slime which, in the presence of the oxygen of the air, oxidizes organic matter.

From the sewage slowly trickling over the surface of this bacterial slime the organic matter is abstracted and decomposed into simpler products. These simpler products are chiefly nitrites, nitrates, carbon dioxide, sulphates, and a brownish-black non-putrescible material, easily sedimented, called humus.

If air is excluded from such beds, the oxidizing action soon ceases, or, if antiseptics are added in sufficient quantity to destroy the bacterial slime, the oxidizing action also ceases.

In the activated sludge method of sewage disposal a similar bacterial mass is gradually formed by blowing finely-divided air through tanks filled with sewage. The sludge which forms by this treatment is allowed to settle, the supernatant fluid allowed to run off, and the tank again filled with sewage, after which the process is repeated. By degrees the sludge which accumulates acquires the same properties as the slime covering the filter-beds. When fully matured this activated sludge will oxidize the organic matter in fresh sewage in from two to four hours; when agitated continuously with it in presence of finely-divided air a perfectly clear and stable effluent is obtained.

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[*] Director of Laboratories, Department of Public Health, Toronto. First published in Journal of Royal Sanitary Institute, December 1916.

The two methods briefly described above are practically identical in principle. In the trickling filter the sewage trickles over the bacterial mass in an atmosphere of air. In the activated sludge method the bacterial mass and sewage are kept in intimate contact by agitation with streams of fine air-bubbles. The end results are exactly the same. Furthermore, as in the trickling filter, the vast majority of the bacteria present in the sewage, including lactose fermenters, and also, presumably, the pathogenic varieties, are destroyed. A single example will suffice to demonstrate several of these statements.

Department of Health Experimental Sewage Disposal Plant, Toronto—Average Analyses, June 20, 21, and 22, 1916.

				Bacteria per red colonies.	
	Free NH_3.	Alb. NH_3	Nitrites and nitrates.	cc. 47°C.	MacConkey 37°C.
Raw sewage	16.0	7.58	2.66	1,453,333	563,333
Activated sludge-tank, 4 hours blowing 2 cubic feet of air per gallon of sewage	8.9	1.9	12.3	5,690	700
Lath-filter, treating 4.5 gallons of sewage per acre per day	10.0	1.7	10.4	9,400	1,266

In 1912, in an endeavor to devise a method for the disposal of the City of Toronto's sewage and reduce the estimated cost of the filter-beds, I began experiments to try to increase the efficiency of the trickling bed, always keeping the principles involved in mind. It was argued that if the amount of surface or bacterial slime could be increased in a given volume, then a greater quantity of sewage could be passed over it and oxydized in a given time.

Experiments were, therefore, designed with the object of increasing the surface of the filter per cubic yard, and of allowing freer circulation of air than the ordinary types of filter-beds permitted. Wood was selected as the material lending itself best to the problem, and the first filter, six feet square, was made of laths. The laths of the lowest layer were laid parallel to one another, the spaces between the laths being a little less than the width of the laths themselves. A second layer was laid on top of this, and at right angles to it, with the same interspace. A third row was laid parallel to the bottom row, but in such a manner that the laths covered the spaces left between the laths of the lower series. In this way a filter four feet in depth was constructed in which the sewage in order to reach the bottom, had to flow over a very large surface of filter. Air could enter from all sides and the top through the regular channels provided—in fact, one can see right through this filter, so uniformly regular are the spaces.

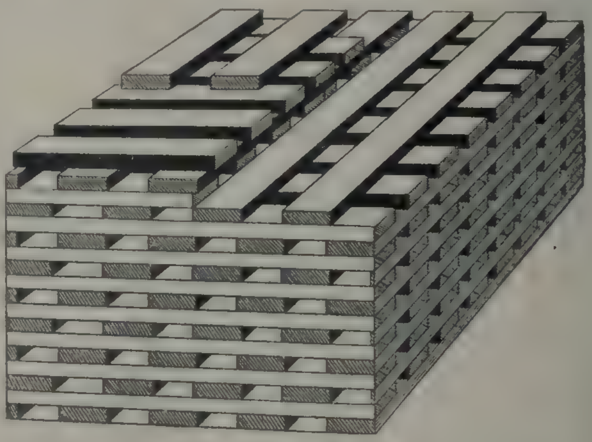
Sedimented city sewage was allowed to trickle over the surface of this lath-filter. In less than a month the filter was mature, and the results obtained thereafter exceeded all expectations. Where the standard type of stone filter, operated side by side with it as a control, treated two million gallons of sewage per acre per day, the lath-filter treated six million gallons and yielded a non-putrescible effluent. This lath-filter has now been in continuous use for three and a half years, and has never failed to give satisfactory results.

From these results we argued that poles might give an even greater surface per unit of volume, because the poles would only come into contact along very narrow surfaces when built into a filter like the laths. Two such filters were built, each six feet square and six feet in depth; after maturing they yielded practically the same results as the lath-filter. They were, however, very difficult to construct; it was difficult, also, to obtain an even distribution of the sewage flow, and short-circuiting of the flow was also liable to occur. This form was abandoned as not being of practical value. One pole-filter, however, was installed in 1914 at the City of Toronto Industrial Farm to treat the sewage from several hundreds of people. No provision had been made for the fact that sewage in small communities frequently comes in gushes, and, consequently, as the bed was overdosed at some periods and had no work to do at others the results were not satisfactory. These defects have recently been remedied.

A filter built of slabs of wood was discarded, as it was only capable of treating sewage at the rate of three and a half million gallons per acre per day.

Finally, having proved our theory to be correct, and having made some preliminary experiments, it was decided that brushwood, pressed into bundles, would make the ideal filter for filter beds, because it would provide the combination of a very large surface area and presence of air which is so essential.

When the Town of North Toronto was annexed to the City of Toronto, a few years ago, it had a system of sewage disposal, part of which consisted of three trickling stone filters, each 30 feet in diameter. In the early spring of 1914 we had the stone removed from one of these filters. Bundles of brushwood, cut from the woods near by, were made on the spot by means of a rough box-press, wired together, and placed in the filter until a depth of four feet had been obtained. A space of one foot was left between the brush bundles and the wall, and a small space in the centre, so as to allow air to enter freely from the sides. The old revolving distributing sprinkler was then put into operation, the brush quickly became matured, and in two months it was treating sewage at the rate of six million gallons per acre per day. A very high degree of nitrification has been obtained; the effluent has been uniformly stable, and the installation has proved to be a decided success. This brush-filter has now been in operation for two years, and has worked just as well in winter as in summer. Of course, it is always necessary to cover filter of every description in winter in Canada to prevent freezing. A brush-filter that was operated in the open to prove whether this would occur in the Toronto climate rapidly froze solid.


Lath filter provides greater surface and allows freer circulation of air

After three and a half years the lath-filter shows no signs of incipient decay, confirming the common experience that wood which is kept constantly wet does not decay. In both the lath and brush-filter the wood is covered with slime, so that the wood is always soaked.

The advantages of the brush-filter may be summarized as follows: (1) Brush is cheap, and may be obtained almost anywhere; (2) skilled labor is not required in construction; (3) it does not sludge; the slime will frequently become quite thin after heavy rains, when the sewage is diluted, though the efficiency of the filter is unimpaired; (4) the brush may at any time be removed and burned (5) it is durable: a filter has now been in operation for over two years without showing any signs of decay; (6) the distribution of the sewage over the surface of the filter does not need to be very uniform; the general tendency is to redistribute itself in the filter meshwork; (7) it gives the maximum amount of surface, with a freer circulation of air in a unit volume of space; (8) it has proved to be a success when treating the sedimented sewage of a city on a large scale, and has treated three times as much sewage to the acre as the standard stone filter will treat.

Unfortunately, on account of the war, I have not been able to give in detail the results which have been and are still being obtained since the filters were put into operation. This brief summary is being given in order that others may avail themselves of our experience. Patents were applied for in the year 1914, in order to protect the City of Toronto until such times as our experiments should be completed. No rights or royalties are claimed, however, in connection with the process. In fact, it is hoped that the cheapness of the system will enable communities to install systems of sewage disposal in districts where the high cost of the accepted types of installation have been prohibitive in price. In the prairie provinces of Canada, for example, where stone would in many cases have to be hauled by train for hundreds of miles and costs a great deal, the brush-filter should solve the problem in regard to expense of installation.

In conclusion, I wish to express my great appreciation of the work of my assistants—Mr. J. Scott, chemical engineer, who has carried out the construction of and has been responsible for the operation of all the experimental filters, as well as the chemical analyses in connection therewith, and Dr. F. Adams, D.P.H., who has supervised this work in my absence. I am also greatly indebted to Mr. R. C. Harris, Commissioner of Works, and to Mr. Worthington, engineer in charge of the sewage system, through the unfailing cooperation and interest of both of whom it has been possible to carry out the experiments on a large and practical scale.

Galt's New Public School

THE architect's perspective which we reproduce herewith illustrates the new public school which is now in course of erection in Galt, Ont. This school is modern and up to date in every particular, and is being constructed with the best materials and workmanship, all of the equipment being of the latest type. In designing the building no superficial ornament or elaboration has been employed, the idea being to produce a building which, of its own general form and proportions, would present a pleasing appearance and be typical of the purpose for which it is intended, so as to obtain the maximum of value at a minimum of cost.

The school is a two-storey and basement structure, and contains eight class rooms, four on each floor. The first floor also contains the principal's office and necessary accommodation; also separate closets for kindergarten and primary departments. On the second floor there are the lady teachers' and nurses' rooms, with private lavatories in connection with each; the rooms are well lighted from the outside. The class rooms are of standard size, 24 ft. x 32 ft., with 13-ft. ceilings. The windows extend to the ceiling, and are finished with splayed jambs, giving the most efficient distribution of light. The light is admitted on the left side of all class rooms. Each class room has its own

Up-to-date Public School at Galt, Ontario separate cloak room, from which it is separated by a brick wall, one door opening into the class room and another into the corridor. All of the doors open in the line of exit. All class rooms, cloak rooms, teachers' rooms, etc., have plastered walls and ceilings, with a cement dado, 3 ft. 6 in., extending around each room.

The structure is of brick construction, with stone foundations. The exterior is faced with fumed flashed pressed bricks of the best quality, laid up in Flemish bond, with dark raked joints. Pressed brick are used for the inner courses. All of the foundation above grade is faced with rock-faced Indiana limestone, in regular courses, each alternate stone being a header. Brickwork has been employed to some extent in the interior finish of the building. In the basement all the stone walls are lined with finished brickwork, and the walls of the lavatories, playrooms, corridors, etc., are of the same material, the best quality of red pressed bricks being employed. The vestibules, also, and all corridor walls on the first and second floors are lined with brickwork, the lower 5 ft. being of fumed floors are lined with brickwork, the lower 5 ft. being of fumed flashed bricks, the same as is employed on the outside walls. This is capped with a brick dado course, and the upper portion of the walls extending to the ceiling is finished with light-colored buff pressed bricks, laid up in white mortar. The ceilings of the corridors and vestibules are plastered.

All rooms are separated by 13-inch brick walls and all interior trimming is of hardwood, in natural finish. The floors of corridors and over the boiler room, etc., are of fireproof construction, being of hollow tile and concrete, supported on steel beams, and finished with the best quality of hard maple flooring, secured to wood sleepers embedded in the concrete. All other floors are of hard maple, laid over a spruce sub-floor with a heavy interlining of asbestos. The stairs from the basement to the first floor are of reinforced concrete, with slate treads, and the stairs from the first to the second floor are of steel construction, having panelled newels and strings, with slate treads and oak hand-rails. The basement ceiling is plastered on metal lathing.

The building is roofed in accordance with the Barrett Specifications. The roofing is flashed to the coping, all brickwork from the roof to the coping being covered by the flashing. The roof is graded to two internal points, and the rain water is carried to the basement, where it is collected in a large cistern, so that the heating boiler may always be supplied with soft water. The roofing is laid over 2-inch matched Norway pine sheathing, supported on 6-in. x 14-in. roofing timbers set 5 ft. apart on centres.

Tool-finished Indiana limestone has been used for the exterior trim of the building, all sills, lintels, coping, and other stone trimmings being of this material. The main cornice and the cornice to the entrance porches is of galvanized iron, and painted and sanded to the same color and texture as the stone trimmings. The main cornice is supported on iron brackets. The roofs of entrance porches are covered with green slate. The roof water from these is carried to the inside of the building.

All exterior doors open to the outside and are protected by porches. Vestibules are also provided at each entrance, with doors opening into the main corridors and also leading to the basement.

The heating of the building is by steam, with direct radiation, on the low-pressure gravity return system, and the temperature regulation is under automatic control. The ventilation of class rooms, cloak rooms, and of the playrooms in the basement is by the single plenum system, the air being supplied from a motor-driven fan in the basement, which draws the air directly from the outside and distributes it to the different rooms. The air is first warmed by being drawn over steam-heated coils, and is under automatic control, a uniform temperature being maintained at all times. The lavatories in the basement are ventilated on the exhaust system, the foul air being drawn off in each by an electrically-operated fan and discharged above the roof of the building. The various cloak rooms and lavatories on the other floors are ventilated separately. The sanitary arrangements are very complete.

The building is electrically lighted, and has a complete system of call bells, a fire alarm system, etc. Fire protection is provided by a large stand-pipe, extending from the basement, with flush cabinets containing valves and hose racks on each floor and in the basement.

Mr. J. Evans, architect, Galt, designed the school, which is being erected under general contract by P. H. Secord & Sons, general contractors, of Brantford, Ont. It will be finished, without extras, at a total cost of about $45,000, exclusive. All brick for the building was supplied by the Milton Pressed Brick Company, of Milton, and the cut stone was furnished by the A. & E. Nobs Company, of London. The steel stairs are being built and set up by the Canada Wire and Iron Goods Company, of Hamilton.

Quebec Superior Board of Health Imposes Filtration Improvements

The towns of St. Anne de Bellevue, Pointe Claire, and Dorval will have to install filtration plants by next October, according to a decision of the Quebec Superior Board of Health, which has declared that the water of Lake St. Louis is unfit for drinking purposes. The question of the City of Lachine, which also uses the same water, will come up later. The City of Hull requested the board to suspend an order that the city's drinking water be filtered, but this was refused, as the board held that the chlorination of the water was only an emergency process, and that the city must put in a filtration plant. The board approved the following suggestions by the Committee on Sewage Disposal and Sanitation of the Canadian Society of Civil Engineers (Mr. A. Surveyer, chairman) to amend the Quebec Public Health Act:

1. Plans for waterworks, filters, sewerage systems, sewage disposal submitted to the Superior Board of Health to be always prepared by engineers qualified to practice in the province.
2. That no by-law providing for the raising of money for the construction, alteration, or extension of any works coming under the jurisdiction of the Board of Health be submitted to the votes of the electors without first being approved by the Board of Health.
3. That extensions or alterations to existing works be submitted to the Board of Health for approval.
4. That rules should be drafted to cover the preparation and submission of projects.

The Joint Committee of Technical Organization has sent out follow-up reminders to men who failed to respond to the first request for information. It is unfortunate that this should have been necessary, as the personal financial strain upon certain individuals is already heavy. The Committeess asks **your** assistance in the form of a prompt reply. Give them your help to this extent—it's war work.

Specifications for Concrete Floors

Suggested Recommendations Covering Preparation, Laying and Finishing of Plain and Reinforced, Single and Double-Course Floors

Continued from last issue

PLAIN CONCRETE FLOORS.

For plain concrete floors the following will apply, in addition to the general requirements:

Subgrade.

30. **Preparation.**—All soft and spongy places shall be removed and all depressions filled with suitable material, which shall be thoroughly compacted in layers not exceeding six (6) inches in thickness. The subgrade shall be thoroughly tamped until it is brought to a firm, unyielding surface.

31. **Deep Fills.**—All fills shall be made in a manner satisfactory to the architect or engineer. The use of muck, quicksand, soft clay, spongy or perishable material is prohibited.

32. **Drainage.**—When required, a suitable drainage system shall be installed and connected with sewers or other drains indicated by the engineer.

33. **Depth.**—The subgrade shall be not less than .... (00) inches below the finished surface of the floor.

Note.—Subgrade to be five (5) inches below the finished surface of the floor when subbase is not required, and at least eleven (11) inches below when subbase is required.

Subbase.

(Omit these sections when subbase is not required.)

34. **Thickness.**—On the subbase shall be spread a material as hereinbefore specified, which shall be thoroughly rolled or tamped to a surface at least .... (00) inches below the finished grade of the floor. On fills the subbase shall extend the full width of the fill.

35. **Wetting.**—While compacting the subbase, the material shall be kept thoroughly wet, and shall be in that condition when the concrete is deposited.

Forms.

36. **Materials.**—Forms shall be free from warp, and of sufficient strength to resist springing out of shape.

37. **Setting.**—The forms shall be well staked or otherwise held to the established lines and grades and their upper edges shall conform to the established grade of the floor.

38. **Treatment.**—All wood forms shall be thoroughly wetted and metal forms oiled or coated with soft soap or whitewash before depositing any material against them. All mortar and dirt shall be removed from forms that have been previously used.

Construction.

39. **Size of Slabs.**—The slabs or independently-divided blocks, when not reinforced, shall have an area of not more than one hundred (100) square feet, and shall not have dimensions greater than ten (10) feet. Larger slabs shall be reinforced as hereinafter specified.

40. **Thickness of Floor.**—The thickness of the floor shall be not less than five (5) inches.

41. **Width and Location of Joints.**—When required by the architect or engineer in charge, a one-half (½) inch space or joint shall be left between the floor and the walls and columns of the building, to be filled with the material before specified under "joint filler."

42. **Protection of Edges.**—Where required by the architect or engineer in charge, the edges of the slabs at the joints shall be protected by metal. Unless protected by metal the upper edges of the slabs shall be rounded to a radius of one half (½) inch.

Concrete Base.

(Two course Floor.)

43. **Proportions.**—The concrete shall be mixed in the proportions by volume of one (1) sack of Portland cement, two and one half (2½) cubic feet of fine aggregate, and five (5) cubic feet of coarse aggregate.

44. **Consistency.**—The materials shall be mixed wet enough to produce a concrete of a consistency that will flush readily under slight tamping, but which can be handled without causing a separation of the coarse aggregate from the mortar.

45. **Placing.**—After mixing, the concrete shall be handled rapidly and the successive batches deposited in a continuous operation, completing individual sections to the required depth and width. Under no circumstances shall concrete that has partly hardened be used. The forms shall be filled and the concrete struck off and tamped to a surface the thickness of the wearing course below the established elevation of the floor. The method of placing the various sections shall be such as to produce a straight, clean-cut joint between them, so as to make each section an independent unit. If dirt, sand, or dust collects on the base it shall be removed before the wearing course is applied. Workmen shall not be permitted to walk on the freshly-laid concrete. Any concrete in excess of that needed to complete a section at the stopping of work shall not be used. In no case shall concrete be deposited upon a frozen subgrade or subbase.

46. **Reinforcing.**—Slabs having an area of more than one hundred (100) square feet, or having dimensions greater than ten (10) feet, shall be reinforced with wire fabric, or with plain or deformed bars. The reinforcement shall have a weight of not less than twenty-eight (28) pounds per one hundred (100) square feet. The reinforcement shall be placed upon and slightly pressed into the concrete base immediately after the base is placed. It shall not cross joints, and shall be lapped sufficiently to develop the full strength of the metal.

Wearing Course.

47. **Proportions for Mixture No. 1.**—The wearing course shall be mixed in the proportions of one (1) sack of Portland cement, two (2) cubic feet of fine aggregate. The minimum thickness shall be three-quarters (¾) inches.

48. **Proportions for Mixture No. 2.**—The wearing course shall be mixed in the proportions of one (1) sack of Portland cement and one (1) cubic foot of fine aggregate and one (1) cubic foot on No. 1 aggregate for wearing course. The minimum thickness shall be one (1) inch.

49. **Consistency.**—The mortar shall be of the dryest consistency possible to work with a sawing motion of the strike board.

50. **Placing.**—The wearing course shall be placed immediately after mixing. It shall be deposited on the fresh concrete of the base before the latter has appre-

ciably hardened, and brought to the established grade with a strikeboard. In no case shall more than forty-five (45) minutes elapse between the time the concrete for the base is mixed and the wearing course is placed.

51. **Finishing.**—After the wearing course has been brought to the established grade by means of a strikeboard, it shall be worked with a wood float in a manner which will thoroughly compact it and provide a surface free from depressions or irregularities of any kind. When required, the surface shall be steel-troweled, but excessive working shall be avoided. In no case shall dry cement or a mixture of dry cement and sand be sprinkled on the surface to absorb moisture or to hasten the hardening, but the Bruner method may be used if desired. Unless protected by metal the surface edges of all slabs shall be rounded to a radius of one-half (½) inch.

52. **Coloring.**—If artificial coloring is used, it must be incorporated with the entire wearing course, and shall be mixed dry with the cement and aggregate until the mixture is of a uniform color. In no case shall the amount of coloring exceed five (5) per cent. of the weight of the cement.

ONE-COURSE FLOOR.

53. **Proportions.**—The concrete shall be mixed in the proportions of one (1) sack of Portland cement to not more than two (2) cubic feet of fine aggregate and not more than three (3) cubic feet of coarse aggregate, and in no case shall the volume of the fine aggregate be less than one-half (½) the volume of the coarse aggregate.

A cubic yard of concrete in place shall contain not less than six and eight-tenths(6.8) cubic feet of cement.

54. **Consistency.**—The materials shall be mixed with sufficient water to produce a concrete which will hold its shape when struck off with a strikeboard. The consistency shall not be such as to cause a separation of the mortar from the coarse aggregate in handling.

55. **Placing.**—After mixing, the concrete shall be handled rapidly and the successive batches deposited in a continuous operation, completing individual sections to the required depth and width. Under no circumstances shall concrete that has partly hardened be used. The forms shall be filled and the concrete brought to the established grade with a strikeboard. The method of placing the various sections shall be such as to produce a straight, clean-cut joint between them so as to make each section an independent unit. Any concrete in excess of that needed to complete a section at the stopping of work shall not be used. Workmen shall not be permitted to walk on the freshly-laid concrete. In no case shall concrete be deposited upon a frozen subgrade or subbase.

56. Reinforcing. — Slabs having an area of more than one hundred (100) square feet, or having any dimensions greater than ten (10) feet, shall be reinforced with wire fabric, or with plain or deformed bars. The reinforcement shall have a weight of not less than twenty-eight (28) pounds per one hundred (100 square feet. The reinforcement shall be placed upon and slightly pressed into the concrete base immediately after the base is placed. It shall not cross joints, and shall be lapped sufficiently to develop the full strength of the metal.

57. **Finishing.**—After the concrete has been brought to the established grade by means of a strikeboard, and has hardened somewhat, but is still workable, it shall be floated with a wood float in a manner which will thoroughly compact it and provide an even surface. When required, the surface shall be steel-troweled, but excessive working shall be avoided. Unless protected by metal the surface edges of all slabs shall be rounded one-half (½) inch.

Canadian Exports Show Substantial Increase

Canadian trade for the last nine months of 1916 showed a tremendous increase according to the recently issued figures given out by the Department of Customs at Ottawa. A gain of approximately $700,000,000 was noted for the period, while exports for this period increased approximately $350,000,000. While the large munitions exports amounting to over $1,000,000 a day accounts in some degree for the large increase in exports, there was also a considerable expansion of general trade. The trade total for the nine months was $1,700,563,269 as compared with $1,012,486,000 for the last three quarters of 1915. The total export figures for the same period of 1916 and 1915 were $861,629,000 and $511,534,000 respectively. Exports of agricultural products showed an increase of $115,000,000 from $202,506,000 to $317,451,000. Animal products showed a marked advance from $78,559,000 to $93,586,000, which is responsible to some extent for higher prices, while products of the mine increased from $49,034,000 to $63,725,000. Exclusive of corn and bullion the increase of exports over imports amounted to $258,763,000.

Recommended Improvements for Trail, B.C., Water Supply

Engineer A. L. McCulloch's recommendations regarding the improvement of the water supply system of Trail, B.C., are contained in a report recently submitted by him to the city council. He advises that Cambridge Creek, supplemented by storage and use of water from Violin Lake, be employed as the source of supply. By this means a low water flow of 1,500,000 U.S. gallons per day can probably be obtained. In order to utilize the storage possibilities of Violin Lake, an earth-fill dam 20 feet high, with 24-inch concrete sluiceway, is suggested, and the laying of a 14-inch tile pipe to Cambridge Creek. From Cambridge Creek it is proposed to lay a wood stave pipe line, 8,400 feet long, to a 1,000,000-gallon distribution reservoir on the west limit of the city. This reservoir would be constructed of earth embankments, with clay lining, and would have an elevation of 373 feet above the main streets of the city. The cost of the whole proposition, exclusive of land, as estimated by Engineer McCulloch, would be $46,500, made up as follows: Violin Lake earth dam, 20 feet high, $3,500; 14-inch pipe line from lake to Cambridge Creek, $6,000; conduit line from Cambridge Creek, 8,400 feet of 8-inch wood stave pipe, $7,500; distribution reservoir, 1,000,000 gallons, with overflow to Trail Creek, $6,000; distribution pipe system throughout the city, $17,500; addition of 15 per cent. for contingencies and engineering, $6,000; total, $46,500.

The largest dam in Europe was recently completed near Barcelona, Spain. Abutting on almost perpendicular cliffs the dam is constructed of concrete and measures 330 feet in height and 700 feet in length. The thickness is 320 feet at the base, gradually decreasing to 14 feet at the top. The valley above the dam is now occupied by an artificial lake 15½ miles long and 3¾ miles wide.

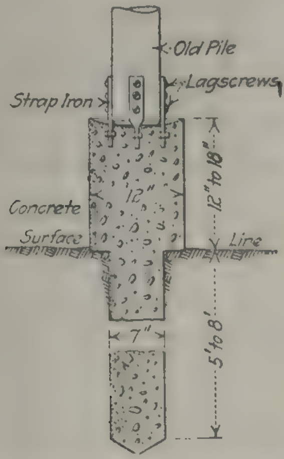
Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Old Bridge Piles Repaired by Using Concrete Base

Replacing piling under wood bridges still in fairly good repair as to caps, joists, and flooring is one of the big items of expense in places where pile bridges are frequent and require maintenance for a number of years. In the Engineering News E. V. Moone describes a method of reducing this expense by putting concrete bases under the piles that have rotted dangerously at the ground line. Replacing a pile always necessitates tearing up the deck of the bridge, removing at least two or three joists and frequently the cap, and sometimes requires falsework for the pile driver. Where the soil is firm and hard and men can work on the ground, a concrete base is put in, retaining the upper part of the old pile. The chief difficulty is to get down past the root of the pile. This has been surmounted in most cases either by pulling or digging out the lower part of the pile, or by moving the top of the pile slightly.

A 7-in. post augur drills the holes to a depth of 5 to 8 feet. Sometimes the holes are reamed out by a "jabbing digger" or a pile spade, which operation allows a mushroom base to be formed. After filling the hole with concrete, a round sheet-metal form, a little larger in diameter than the hole, is placed at the surface. In the form three or four iron straps are placed, so that they will project 8 to 12 inches above the concrete. Each strap is drilled for two lag-screws, and the straps are placed so that the pile slips between them.



Concrete base for old bridge piles

The top of the base is pressed down or cupped, using either a wood form or a trowel. This device helps to keep the pile firmly in place. The concrete sets for 48 hours before the pile, which is secured with the lag-screws, is placed.

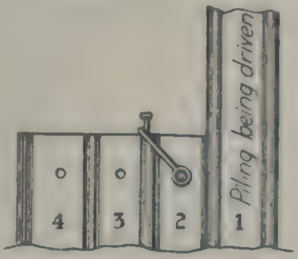
A number of bridges thus repaired have sustained heavy floods without damage. Under favorable conditions this method of repair is much cheaper than replacing old piles with new, and it seems to be more lasting.

Shackle Prevents Piling from Creeping

Considerable difficulty encountered in holding steel sheet piling to the proper elevation during driving was overcome by securing each pile to the next with a long shackle, as shown in the sketch, from Engineering Record. This method was adopted in connection with the construction of a river dam.

The piles were of the 14-inch arched web type, 40 feet in length. They are a permanent installation, driven on the upper edge of the navigable pass foundation, and extending 3 feet into it. In the sketch, pile 1 represents that being driven, while piles 2, 3, and 4 have been previously driven.

During the driving of pile 1 pile 2 would creep below grade, due to the friction between the piling. In some cases the creeping of pile 2 would commence as soon as the driving was started on pile 1. If this had been allowed to continue until pile 1 was driven to grade, pile 2 would have been from 10 to 12 feet below grade. The method used to prevent the creeping of the piling was to fasten a shackle to pile 2 with a 1¼-inch short bolt, lay the other end of the shackle over the top of pile 3, and insert a bolt in the joint between piles 2 and 3 to prevent the shackle from being pulled off. After the shackle was in place, pile 2 would continue to creep for about an inch, until the shackle became tight. In one or two cases the friction developed in driving was so great that pile 2 would continue to creep, carrying with it pile 3. This necessitated an additional shackle between piles 3 and 4.



Piling kept from creeping below grade by shackle

The shackle was about 15 inches long, made from 1-inch soft steel. The piles were driven with 3½ and 4-ton steam hammers.

"The people of Canada should practice economy, which results in greater national saving. Every man over twenty-one understands how to economize, and every man can carry it out if he wants to carry it out. Let us economize. Let us make our savings serve the purposes of war. Let the people of the Dominion, by thrift and economy, make their dollars fight the Hun."—Sir Thos. White.

Blasting with Liquid Air

Blasting with liquid air is said to have been rapidly developed in Germany since the beginning of the war. Holes drilled in rock are charged with five cartridges, which are simply small bags soaked in a bucket of liquid air after they have absorbed a sufficient amount of it, when they are jammed, like wet rags, into the drill hole with a stick, and fired by electricity. A single 90-grain cartridge costs approximately 6/10′ as much as an equivalent dynamite cartridge. It is said to be 50 per cent. more powerful than dynamite and the cost just about one-half as much in large quantities.

Multiplying the Reach of a Derrick Boom

A boom derrick used to handle spoil excavated from the lock pit for a Texas canal was rigged so that the spoil bucket handled by it could be dumped at a distance of 300 feet from the mast. This was effected by rigging a trolley line cable from the bottom of the mast to a sheave on the end of the boom, thence through the bottom block of the hoisting tackle, and to the top of the tail tower, where it was made fast. The boom was topped and the bucket hoisted, and was then allowed to move downward on the inclined trolley cable to the required point, where it was dumped and then returned for another load.

It was found that for a distance of 300 feet a 12 foot drop was required, and that a load of 2,500 pounds was necessary for operation on this flat slope. In soft, wet ground a gang of seven men, including foremen and hoister, could handle 137 buckets in eight hours.

Letter to the Editor

The following letter, referring to pavements and highways, is a special plea for providing better foundations than have been used in general in the past. It is pointed out that our roads do not wear out as a result of increased traffic, but rather that they are broken down by the increasingly heavy traffic made possible by modern automobiles, motor trucks, etc. We believe the point is well taken that too little attention has been paid to road foundations and that at a comparatively small increase in cost a much longer life would be obtainable.

February 1, 1917.

Editor Contract Record:

This company has been building pavements and roads and producing highway materials for thirty-three years. We feel that our position in the road-building industry imposes a certain responsibility upon us. It is in the discharge of such responsibility that we point out a serious and costly error now being made in practically all communities, namely, the failure to provide adequate foundations for country roads and, in many cases, for city pavements.

Our roads are not wearing out by increasing quantity of traffic nearly so fast as they are being broken down by increasing weight of traffic. The remedy for this condition is the adoption of more substantial bases for new roads in rural districts as well as in cities. Used in this way for foundations, concrete serves its true function as a road material. Protected by asphalt wearing surfaces, it does not exhibit the heaving, cracking, and disintegration that is seen when concrete is exposed as a road surface to varying moisture and temperature conditions.

On the other hand, the support afforded by concrete to asphalt wearing surfaces is as beneficial in the building of enduring highways as is the protection of the base provided by such surfaces.

The road of asphalt and concrete is, therefore, the best dependence of those who desire durability and a means of carrying present traffic weights. It is earnestly recommended, therefore, that taxpayers and those who represent them should act in their own interest and demand, if concrete is to be used, that both it and asphalt shall be employed, not necessarily so as to consume the maximum amount of either, but so as to get maximum service from each.

The purpose of this letter to you is not to suggest that the ideas we express should be accepted by you unquestioningly as gospel, but that you do permit them to effect such a lodgement in your mind as will lead you to keep them before you and to test their accuracy at every possible opportunity.

The element of self-interest in these suggestions is this: That we believe the highest success of any product is dependent upon its wisest—not necessarily its largest—use.

Very truly yours,

The Barber Asphalt Paving Company,

A. W. Sewall, President.

Toronto Branch C.S.C.E

On Tuesday, February 13, the Toronto branch of the Canadian Society of Civil Engineers held its regular monthly meeting in the Mining Building of the University of Toronto. The meeting was addressed by Dr. A. P. Coleman, professor of geology, University of Toronto, on "Labrador Revisited," a description of his recent trip along the coast and in the interior of this vast and unknown wilderness. The talk was for the most part descriptive of numerous colored lantern slides.

Mainly Constructional

East and West—From Coast to Coast

Messrs. R. S. & W. S. Lea, consulting engineers, Montreal, have reported to the City of Granby, P.Q., on the supply of water for fire prevention.

A by-law has been passed authorizing a good roads system for Brant County, Ont. . Very little construction work, however, will take place this year.

The Department of Public Works have started soundings on the River Thames in connection with the proposed 14-foot channel from Chatham, Ont., to Lake St. Clair.

The Sarnia Board of Trade has asked the City Council that exemption from taxes be granted for a year on all new houses built in the city. This, it is thought, will stimulate activity in the building trade.

The Woolworth Company propose to erect a 5 and 10-cent store in Welland, Ont. The block will be of brick construction, and will have a frontage of 40 feet on East Main Street and 100 feet on Cross Street.

Ground has been broken for the new plant of Aeroplanes, Limited, on Dufferin Street, Toronto, and the work of construction will be rushed through. It is understood the plant will be ready for operation in two months' time.

A rumor is afloat to the effect that work on the big departmental store which it is proposed to erect in Toronto at the corner of College and Yonge Streets may be delayed to July, 1918. It is stated that the lessees in the block have received an offer of the renewal of their leases.

The newly-completed sewerage system in West Toronto exceeds the estimate by nearly $600,000, the cost being $2,295,939, instead of $1,701,784. This increase was largely due, the Works Department says, to the main sewers being made larger in order to help carry county sewage.

The Society of Beaux Arts Architects of New York have passed a resolution expressing regret at the grievous loss to the society and to architecture by the death of Captain G. H. Blackader, of Montreal; also expressing "its pride in his glorious death for the cause of liberty and justice."

The Imperial Bank has purchased the 50 x 120 foot corner at Hastings and Homer Streets, Vancouver, B.C., for the sum of $130,000, and will erect a new building for their own use. This price works out about $2,600 a foot, which is considerably lower than any price paid for Hastings Street property for some time.

Hon. Robert Rogers, Minister of Public Works, recently announced that a new contract had been prepared for the St. John, N.B., harbor works, and that tenders would be called for immediately and work carried on as expeditiously as possible, the Norton-Griffith Company having failed to carry out the original contract.

The Town of St. Mary's has recently purchased from the Storey Pump and Equipment Company, Toronto, an 8-inch, 3-stage Morris centrifugal pump, capable of delivering 1,000 imperial gallons per minute against a 300-foot head. The pump is driven by a direct-connected 140 h.p. marine type Van Blerck gasoline engine.

The City of Sarnia will in the near future provide a mechanical chlorine plant for the old waterworks, which takes its water from the St. Clair River through an intake pipe extending 750 feet into the stream. At the present time chlorinating is done by a plant operated by a man, and this has been found to be very uncertain.

Hamilton contractors and real estate men, according to report, are looking for an unusually large amount of building work in that city this coming summer. It is said that the large number of advance plans now being prepared and enquiries being made among real estate men by citizens relative to the purchase of building lots warrants this opinion.

The Mack Brick Company, Ltd., just incorporated, have acquired land at Delson Junction, P.Q., and propose to erect a brick making plant. Mr. P. S. McKergow, secretary of the National Brick Company of Laprairie, Ltd., and Mr. L. W. McArthur, general superintendent of the same company, have resigned their positions, and are interested in the new concern.

Three tenders for the completion of the Manitoba Parliament Buildings were received by the Department of Public Works on Feb. 12. The tenderers were George A. Fuller Company, Ltd., Winnipeg, whose bid of $1,171,823 was the lowest; J. McDiarmid, Ltd., Winnipeg, whose bid was $1,182,981, and the William Cowlin Company, Ltd., Toronto, at $1,197,508. Numerous other tenders were received on special branches of the work, in addition to three on the general contract. The tenders will be considered by the government in due course.

The Montreal Court of Review has sustained the judgment of the Superior Court in awarding Dame Georgette Roy, former proprietress of the St. John's, Que., waterworks, $112,750 for the properties expropriated by the town. The town had offered $50,730 and the owners wanted $408,380. They were awarded $112,750, but the municipality appealed, with the above result. The sum awarded is held to represent $100,000 for the material value of the works and $12,750 as compensation for net revenue from 1912 to 1922, when the charter would have expired.

Hon. Finlay Macdiarmid, Provincial Minister of Public Works, told a deputation from Lincoln and Wentworth counties which visited Toronto recently that a road from Hamilton to some point on the international boundary would necessarily be included in the proposed system of provincial highways, legislation for which would be introduced at the coming session of the legislature. The deputation, consisting of over fifty representatives of the counties mentioned, appeared in connection with the establishment of a provincial highway along what is known as the Queenston and Grimsby road leading from Hamilton through Stony Creek, Grimsby, Beamsville, Vineland, Jordan, St. Catharines, and St. David's. The Wentworth delegation urged a concrete road, at an estimated cost of $25,000 per mile, while the Lincoln delegation requested that a 26-foot bituminous roadway be constructed, at a cost of $15,000 per mile. The total cost in the former case would be $1,100,000 and in the latter $660,000, the road extending 44 miles

Personal

Mr. Edwin H. Verner has been appointed municipal engineer for Langley, B.C., and will also act as chief of police. He formerly held a similar position for Port Coquitlam and Coquitlam Municipality.

Mr. F. E. Field, the engineer who has represented the city during the construction of the Montreal filtration plant, has been appointed superintendent engineer. This is in anticipation of the plant coming into early operation.

Mr. J. W. B. Blackman, city engineer of New Westminster, B.C., has enlisted for overseas service. The City Council has granted him indefinite leave of absence, and has appointed Assistant Engineer Stewardson to act in his place.

Doctor and Mrs. A. D. Blackader have decided to establish at McGill University a memorial in honor of their son, the late Lieutenant Gordon H. Blackader, who was a graduate of architecture at the university. This will take the form of a sum of money to be invested, the interest to be devoted to the purchase of books on architectural subjects. This will be known as the Gordon Home Blackader Memorial Library.

Obituary

Word has been received in Montreal of the death of Mr. J. G. Macklin, civil engineer, who left Canada some six years ago to reside in England, owing to failing health. Mr. Macklin, who was a member of the Canadian Society of Civil Engineers, was born in England, but came to this country as a young man. He began his professional career with the late Colonel Sir Casimir Gzowski, on the construction of the cantilever bridge spanning the Niagara River. Subsequently he joined the staff of the Grand Trunk Railway, and became chief engineer of the Midland division of that company. The last important work on which he was engaged was the planning and construction of the power plant on the Richelieu River at Chambly, P.Q.

Trade Publication

The London Concrete Machinery Company, London, Ont., hve recently issued a minfature catalogue of 48 pages, showing and illustrating in condensed form the entire line manufactured by that company. This company has just secured the contract to supply Messrs. Church & Ross, contractors, with two No. 14 half yard batch concrete mixers, to be used on the Imperial Munitions Board's new plant at Trenton.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Amherst, N.S.

The Town Council is considering the construction of a sewer to cost $5,000. About 2,000 feet of 24-inch glazed sewer pipe will be required. Engineer, J. E. Parker.

Edmonton, Alta.

The City Council contemplate installing a 5,000,000 gallon per day capacity sewerage disposal plant to cost $600,000.

Leamington, Ont.

The Town Council contemplate the construction of new sewers. Clerk, R. M. Selkirk.

Ottawa, Ont.

The Central Canada Exhibition Association, City Hall, are considering the construction of macadam roads with Tarvia finish in the Exhibition Grounds.

Toronto, Ont.

F. Barber, Engineer, 57 Adelaide St. E., will call shortly for tenders for construction work on waterworks system in York Township.

CONTRACTS AWARDED

Ottawa, Ont.

Tarvia road work, to cost $97,000, for the Ottawa Improvement Commission, 110 Wellington St., is to be done by the Tarvia-Patterson Manufacturing Company, Montreal, by day labor, under Engineer Alex. Stuart, care of Commission. Tenders for supplies will be called in March.

Railroads, Bridges and Wharves

Minitonas, Man.

Tenders will be received by the Secretary-Treasurer, J. H. Cannon, of the Municipality of Minitonas, until March 5th, for the erection of a 90-ft. bridge over Woody River. Plans and specifications with the Secretary-Treasurer or at the office of the Highway Commissioner, Winnipeg.

Toronto, Ont.

R. C. Harris, Commissioner of Works, has prepared an estimate for the extension of Bloor Street car line by single track on Bloor Street from Quebec Ave. at $30,000.

CONTRACTS AWARDED

Colchester South Township, Ont.

Jas. McGill, Harrow, Ont., has been awarded the general contract for the erection of a bridge for the County of Essex; cement, wood pile, steel construction. Engineer, Owen McKay, Walkerville.

Public Buildings, Churches and Schools

Amherst, N.S.

The Town Council contemplate the erection of a brick fire hall costing about $3,000. Clerk, W. F. Donkin.

Halifax, N.S.

A. R. Cobb, architect, Tramway Bldg., is preparing plans for a $50,000 church to be erected by the St. John's Presbyterian Church. Tenders to be called shortly by architect.

Preliminary plans are being prepared for addition to Richmond School at a cost of about $15,000 by the Board of School Commissioners, 81 Sackville St. Tenders will be received shortly by the Board. Plans and specifications with architects, Harris & Horton, Keith Bldg.

Tenders are being received until February 26 for the erection of a reinforced concrete abattoir to cost about $25,000. Clerk, T. F. Monaghan. Plans, etc., with Mr. Barrett, 10 Lower Water Street.

Hamilton, Ont.

The Victoria Yacht Club contemplate alterations to club house to cost $6,000. President, E. Harris, care of Herald Printing Company.

Listowel, Ont.

Tenders will be received by the architect, W. E. Binning, Imperial Bank Bldg., until March 5th, for an addition to school. Plans and specifications with architect.

Tenders are being received by the architect, W. E. Binning, Imperial Bank Building, until March 5 for the erection of addition to High School, etc., costing $20,000. Plans and specifications with the architect.

London, Ont.

Dr. Robinson, Superintendent of the London Hospital for Insane, plans to install natural gas, and build pipe line and distributing mains.

Ottawa, Ont.

The City Council are considering raising $20,000 to erect a Carnegie branch library. Librarian, W. J. Sykes, Metcalfe Street.

The Carleton County Council contemplate remodelling interior court room on Nicholas Street and erecting additional waiting rooms. County Clerk, Chas. McNab.

Sherbrooke, Que.

H. G. James, Whiting Block, is preparing plans for a $5,000 addition to school owned by the Protestant School Board Commissioners. Secretary-Treasurer C. O. Palmer, Record Block. Blackboards and seating will be purchased by the School Board.

St. Eusebe, Que.

The Curate, Rev. J. W. Dionne, is open to receive quotations on cement, lumber and tin roofing for the erection of a church to cost $15,000. Architect, Thos. Raymond, 45 Caron St., Quebec.

St. John, N.B.

F. Neil Brodie, 42 Princess Street, has been appointed architect for the Nurses' Home addition and public hospital to be erected at a cost of $125,000 by the City and County of St. John.

St. Julienne, Que.

Tenders are being received by the School Commission for the erection of a school of frame construction to cost $6,000.

Weston, Ont.

The Weston Driving Club have offered to erect suitable buildings on the Fair Grounds for rights to use track, etc. Cost, $3,000.

Wyoming, Ont.

Plans are in progress for two-storey, $15,000 church to be erected by the Methodist Congregation. Tenders will be received by the Pastor after March 1st. Architect, A. J. McKinney, 163 Riddell Street, Woodstock.

CONTRACTS AWARDED

Dartmouth, N.S.

Falconer & McDonald, Halifax, have been awarded the general contract and will do all work in connection with the erection of a one-storey, concrete and brick hospital for the Provincial Government. Engineer, A. C. McNeil.

McGregar, Ont.

The general contract for the erection of a school to cost $5,000 for Father J. A. Pinsonneault has been awarded to J. L. Dufour, 132 Aylmer Ave., Windsor, Ont. Work will commence as soon as possible.

Paris, Ont.

The following contracts have been awarded in connection with the erection of a Y. W. C. A. building on Broadway West by Penman's Ltd., at a cost of $15,000:—General contract, Schultz Bros. Co., Ltd., 37-49 Albion St., Brantford; electrical work, Fred Webster, 211 Colborne St., Brantford; plumbing and heating, Anguish & Whitfield, 40 Colborne St., Brantford; painting, R. C. Chave, 17 Pearl St., Brantford.

Pointe au Pic, Que.

Treffle Bergeron, Lamalbaie, has been awarded the general contract for the erection of a church and presbytery for the parish, to cost $37,925. Architect, J. P. Ouellet, 28 St. Famille St., Quebec.

St. Francois Xavier, River du Loup, Que.

Dumont & Cote, Fraserville, Que., have been awarded the general contract for the erection of a four-storey, stone and brick convent for Soeurs Enfant Jesus. Architect, J. S. Bergeron, 103 St. John St., Quebec.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **February 28, 1917** **No. 9**

Principal Contents

Page
Editorial ... 173
Constructional Details of Big Aqueduct ... 175
Matters of Interest to Engineers and Contractors Discussed at Montreal Builders' Exchange ... 178
Advance Planning and Time Schedules Secure Rapidity and Economy ... 179
Pneumatic Caisson Work on the Piers of the Petitcodiac River Bridge at Moncton, N.B. ... 180
Best Practice in Road Construction ... 186
  Concrete Roads ... 186
  Earth and Gravel Road Maintenance ... 187
  Developments in Brick Pavement Construction ... 189
Practical Hints for Contractors ... 190
Mainly Constructional ... 191

A Civil Service Rule for Government Inspectors

STRUCTURAL failures occurring in connection with engineering works can often be attributed to a lack of efficient and careful inspection as the work of construction has progressed. Incompetence on the part of inspectors has become so common as to cause little more than passing comment. without any very stringent attempts toward providing remedial measures. Yet efficient inspection should be an essential requisite in structures that are or may be called upon to shelter human life. The methods and materials of construction are so subject to variation in quality and workmanship that attention to every last and apparently insignificant detail is essential. It is strictly true, in construction work in general, that eternal vigilance is the price of safety.

Buildings or other engineering works erected by or for private corporations are not so subject to the charges of incompetent inspection as structures erected under municipal or government supervision. With privately erected buildings reasonable care in erection is a matter of course, since the reputation of contractors is staked upon successful completion of work and the owner watches his own interests as closely as may be. On government owned and supervised projects, however, there is always the opening—not always taken advantage of we are glad to say—for the exercise of political patronage. The great curse to which all work carried out by a governmental body is subject to is the abuse of political privileges. In too many cases this has led to the employment of civil servants on account of the service they have rendered their party rather than for their ability or acquaintance with the particular work on which they are employed.

Appointments on the basis of political attachments have applied,as in other lines, to the inspectors on government work, with the result that personal or party friendship plays a more important part than ability to properly carry out the work to which they are appointed. The outcome is evident in the poor results in many governmentally supervised projects. The defects which appear often have to be covered up by added expenditures, resulting in exceeded estimates.

* * *

The only remedy for such a condition of affairs is, of course, to get at the root of the matter and eliminate the effect of the political element in governing the choice of engineering or allied appointments. Appointees as inspectors and engineers on public work should be qualified to fill their positions, and ought to possess the ability demanded by the nature of the work. What we advocate is a system of appointing young qualified civil engineers into the positions of inspectors, under, perhaps, a civil service qualification. This method is adopted by the Federal Government of the United States, with prominent success. Their example can well be followed in Canada with vastly improved results over our existing practice. By making a civil service rule the basis of engineering appointment, a grade of engineering inspectors would be assured which would be, as far as possible, beyond reproach. Competitive examinations, eliminating political influences and bringing in true ability, would secure for responsible positions only such men as were properly suited and experienced.

* * *

If civil service regulations served to regulate technical appointments, there is little doubt but that a great many young men going through our colleges would especially prepare themselves for this work, and by not having to answer to some political influence that secured them their positions their decisions would be along straighter and more honest lines; by basing promotion on merits every endeavor would be made to produce satisfactory results.

Planning in Advance

ECONOMY is the aim of every builder. Both the contractor and the owner demand the most for the least money, compatible with quality.

Under existing conditions, with high prices and unprecedented labor scarcity, economy is more essential than ever. The difficulties attending building operations at this time make it abnormally expensive and have resulted in many deferred projects. In these columns the more extensive employment of labor-saving appliances has been frequently advocated. The substitution of mechanical plant to perform many of the duties of human labor realizes an economy that, with reasonable operation and foresight, ought to result in a saving that will more than offset the increased capital expenditure. With mechanical equipment or without, there is one way, however, in which a great measure of economy may be attained. Systematization of all operations is a matter in which most contractors, especially the smaller ones, are sorely lacking, and yet, by a proper correlation of all operations in a systematized manner, it is self-evident that the elimination of waste and duplication will bear fruit in increased profits.

If speed is a consideration, it is vital to have all operations co-ordinated to avoid unnecessary overlapping. This is simply and efficiently accomplished by having the different elements of the construction work harmonize so as to avoid interference of one part with another, and so as to have labor, materials and plant in readiness at the proper time. The organization can thus be systematized to do its best work in the least time with a minimum waste of effort.

Elsewhere in this issue we outline a method adopted by a well-known contracting firm in connection with its work in large buildings. The systematization in this case is carried out to almost the last degree, but it results in an admirable nicety of operation. The principle of this plan is to provide in advance a definite program for all the operations that can be classified, and then to adhere, as strictly as circumstances allow, to this schedule. The materials are bought, supplied and used in accordance with a similarly drawn-up system, so that there is no confliction of operations or delays in obtaining work, labor or materials.

This particular method may apply to only the more elaborate projects, but there is much of value for all contractors. Advance preparation, followed by careful application of the system, together with a well-organized staff, enables contracts to be carried out rapidly, accurately, and economically in a manner that could not be obtained without such special control. Moreover, a check is provided on irregularities and the progress of the work is easily controlled from headquarters.

Fourth Canadian and International Good Roads Congress

THE prospects are exceptionally bright for the success of the Fourth Canadian and International Good Roads Congress, to be held under the auspices of the Dominion Good Roads Association. The scene of this year's Congress is to be the capital city, Ottawa, and the Convention and Exhibition will be held in the Horticultural Building in Lansdowne Park, on Banks Street, twelve minutes from the centre of the city by street car. The Congress will assemble on Tuesday, April 10th, the day after Easter Monday, and will continue until the following Saturday. The Horticultural Building, which has been placed at the disposal of the Congress by the city authorities, is especially adapted for the purposes of such a gathering, being of brick construction with concrete floor, the interior being spacious and bright. The downstairs portion will be given up to the annual exhibition of road machinery, materials and accessories, while upstairs there is a large convention hall, together with committee rooms, and accommodation for the registration bureau. Freight sidings give unusual facilities for the unloading and reloading of heavy exhibits, while the street cars pass within a few yards of the building.

An interesting program is being prepared, with papers and addresses by Canadian and outside experts, while practical road builders from Canada and the United States will be present and take part in the informative discussions which are an important feature of every congress. Profiting by the experience of the past, it is the intention to have the different lecturers and speakers simplify their deliverances as much as possible, so as to make them clear to the non-technical delegates, especially those from the rural districts, of whom there are each year an increasing number.

In conjunction with the Congress, the fourth annual Good Roads Exhibition will be conducted on a bigger scale than ever. Leading Canadian and United States manufacturers of road machinery and materials have announced their intention of placing on view a full line of their products, ranging from the simplest tools to the most modern inventions. Materials, both in the form of samples and constructed sections, will be shown in great variety, and there will be miniature models of roads, and a wide range of engineering instruments and other accessories for the making of good roads.

The Dominion Good Roads Association, desirous of obtaining greater legal powers and of broadening its scope and increasing its usefulness, will present a bill before the adjourned session of Parliament, asking for Dominion incorporation. The details of this bill, as well as the new Constitution and By-laws, will be explained to the delegates, who will be asked to ratify the measures taken by the executive. The constitution will follow the general lines adopted by similar organizations in the United States, with such modifications as are suggested by local conditions.

Uncertainty in Montreal Building Situation

AT this early period nothing much of a definite character can be stated as to the outlook for the 1917 building season in Montreal. Architects and contractors say that there is not a great deal of work in sight, but it is believed that the season's programme will be on similar lines to that of last year. No new office buildings of any importance are expected, as Montreal has sufficient accommodation of this class to more than provide for every need. The bulk of the work is likely to be on ammunition plants or on buildings which are more or less dependent on the war; when peace comes these will be undoubtedly turned to industrial account. There is need for more houses and flats, but, owing to the high price of material, little inducement is offered for land-owners to build. It is estimated that the cost has gone up at least 30 per cent. as compared with two years ago, and it is probable that there will be only a slight reduction when war ceases. For several months after hostilities commenced builders were in a position to construct at a very low rate, but little was done, owing to the uncertainty as to the outlook. Now that prices have advanced, it is argued that the cost is too high, and that building must be postponed until conditions become normal.

Constructional Details of Big Aqueduct

First of a Series of Articles Being Prepared Specially for the Contract Record by the Division Engineers of the Greater Winnipeg Water District—First Article Covers General Features of the Project with Description of Methods Employed in Supplying Graded Aggregate for Concrete

By Mr. Douglas L. McLean*

A SERIES of six articles dealing with the contractors' organizations, plant, and methods used on the construction of the 85-mile concrete aqueduct section of the Greater Winnipeg water supply, has been prepared for this magazine by the division engineers of the Greater Winnipeg Water District. As an introduction to these articles, which deal with particular phases of the work, the following is given to describe the general features of the project and also the work done by the Water District's own forces, particularly in the matter of supplying transportation and graded aggregate for concrete.

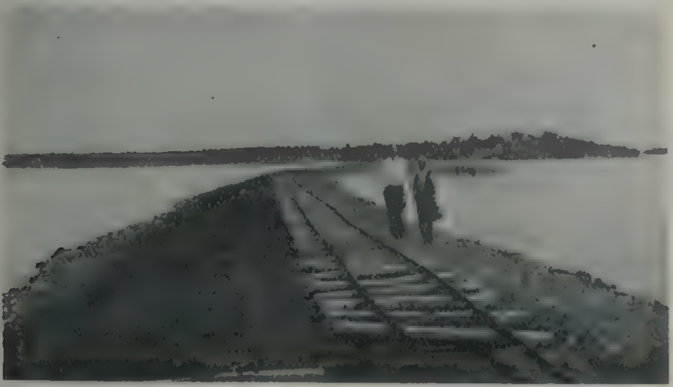

Fig. 1 —Greater Winnipeg Water Supply—Falcon River Dyke near north end

In order to bring in a supply of eighty-five million imperial gallons per day from Shoal Lake to Winnipeg the following works for a gravity system of supply are being constructed, at an estimated cost of $13,500,000.

1. Intake at Indian Bay, an arm of Shoal Lake, Ont., with screens and necessary regulating equipment.

2. Falcon River diversion dyke and canal. These works divert the dark-colored muskeg waters of the Falcon River into Snowshoe Bay, away from Indian Bay, where the intake is located. The distance through which the water will have to travel from Snowshoe Bay to the intake is such that the natural agencies of the sun, waves, and wind will have time, before the water could reach the intake, to bleach it and make it as clear as the water of the main lake. (See Fig. 1.)

3. Eighty-five miles of concrete aqueduct and appurtenant works. For 77.6 miles of the conduit a horseshoe shaped plain concrete aqueduct, with invert, reinforced where yielding foundations occur, is being used. For the balance of the line, being the six river crossings and the pressure section leading to the future reservoir site at Deacon, circular reinforced concrete pipe is being used. A minimum of four feet of backfill is placed over the aqueduct for frost protection. (See Figs. 2 and 3.)

4. Nine and one-half miles of reinforced concrete pipe, lock-joint type.

5. Tunnel under the Red River.

6. Two and three-tenths miles of cast iron mains through the streets of Winnipeg to McPhillips Street reservoir.

Difficulties Attending Construction

The country through which this conduit is located may be described as flat and poorly drained. While appearing level, with slight natural drainage flowing northwestward, nearly parallel to the aqueduct line, the country between Shoal Lake and the City of Winnipeg actually has a fall of 294 feet. The first twenty-five miles of the conduit to the east of Winnipeg is through open prairie; the next fifteen miles traverses wooded and rolling prairies, with many sand and gravel ridges, and the remaining forty-seven miles runs through wooded bog or peat-covered country, which, however, has very considerable areas of arable land bordering the rivers. The difficulties attending construction through this country are lack of transportation facilities, poor drainage, and foundation troubles arising from local deposits of silt, quicksand, and soft clay. As a marked offset to these, the remarkable natural grades obtained in this country permitted uniformity and simplicity of construction, which tended to minimize the cost of the undertaking. Another asset afforded by the region was the gravel deposits which made conveniently available ballast for the railway and first-class aggregate for the manufacture of concrete.

Construction Railway Parallels Aqueduct

Before the 85 miles of concrete aqueduct could be built it was necessary to provide some means of transporting the required materials and construction equipment. The most feasible and cheapest means to this end appeared to be a standard gauge railway, and this was constructed by the District in 1914, at a cost of $12,800 per mile. This road is located on the same right of way as the aqueduct and parallel to the aqueduct centre line at a distance therefrom of 110 feet, which location enables the railway to deliver construc-

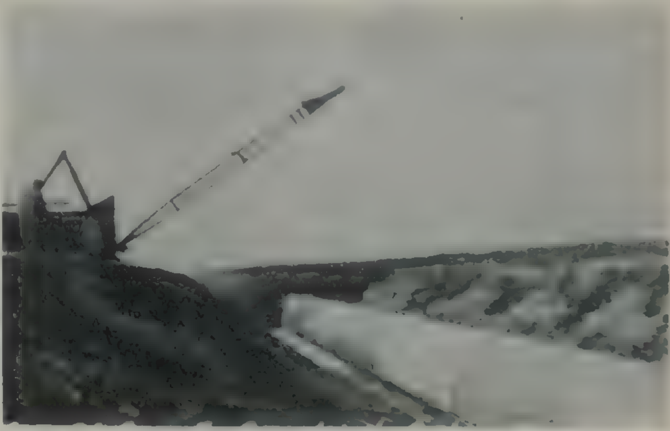

Fig. 2 Arch section of aqueduct ready for backfill.

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* Assistant to the Chief Engineer

tion materials right at the site of work. This railway is operated by the Water District.

Following the building of the railway in 1914, work commenced in the spring of 1915 on the contracts for the 85 miles of concrete aqueduct. The contracts were awarded as follows:

Contract No.	Mile to mile.		Contractor.
30	13	33	J. H. Tremblay Co.
31	33	51	Thos. Kelly & Sons
32	51	69	Winnipeg Aque. Con. Co.
33	69	85	" "
34	85	97	" "

In the two construction seasons of 1915 and 1916 the contractors completed 42 per cent. of the work. This is 8 per cent. below schedule, and they are taking steps to speed up their work in 1917 so as to complete the work by the fall of 1918.

Sequence of Operations

The building of the aqueduct consists of the following operations: First a trench is excavated to within about six inches of the bottom of the invert or floor of the conduit. Then just before placing the concrete for the invert this six inches of earth is removed by hand excavation. Next the invert or floor of the aqueduct is poured in 15-foot sections, with a crimped copper water stop between the 15-foot sections. Following this the arch sections are poured in 45-foot lengths, with the same type of copper water stop expansion joint as is used in the invert. The construction joint between the arch and invert has a wooden water stop, consisting of a fir strip ⅞ in. x 1¼ in. After the concrete has aged sufficiently, backfill is placed over the arch to a depth sufficient to give, after settlement and trimming, four feet of cover for frost protection. Finally the backfill is seeded and the right of way cleared of all objectionable construction debris.

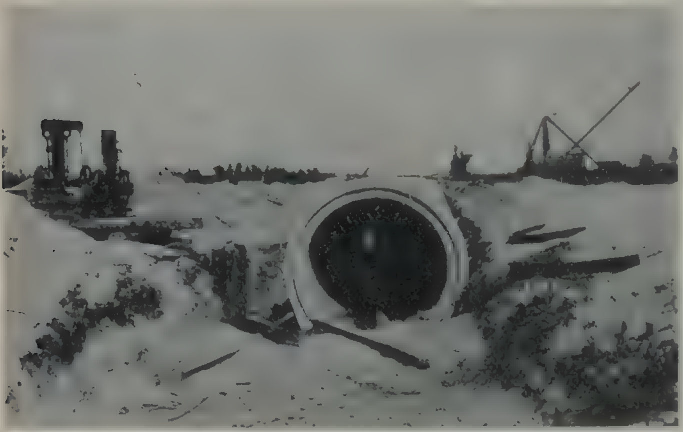

Fig. 3—Reinforced circular pressure section of aqueduct at Brokenhead River crossing.

While the major portion of the work of the aqueduct construction has been carried on by the contractors, there has been also some considerable work done by the District's own plant and forces. This work has consisted in the supplying to the contractors, at the fourteen working points, the cement and graded aggregate required for the manufacture of the aqueduct concrete. The Portland cement is purchased annually by the Water District from the manufacturers. Storage in bins sufficient for two months' demand is supplied at the mills, from which, after rigid testing, the cement is shipped as required in carload lots to St. Boniface, Man., for delivery over the Water District Railway. On arrival at the site of the contractor's work the cars are unloaded by the contractor's men, and the cement is placed in watertight galvanized iron or heavy flax canvas sheds. The cement is supplied to the contractor at cost, and when it is placed in the work, credit is given for the amount so used.

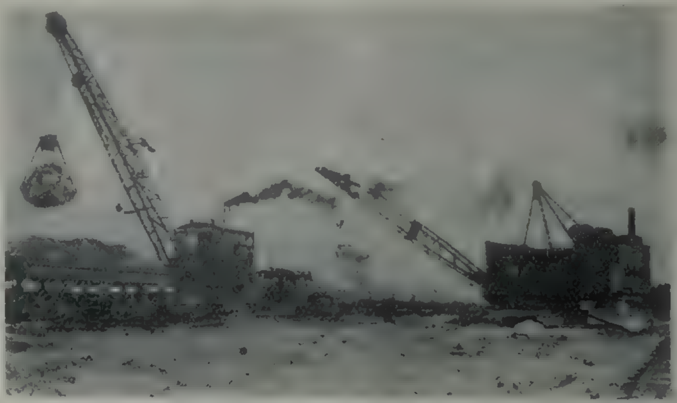

Fig. 4—Pit No. 1. Dragline loading gravel into 6 cu. yd. dump cars. Browning crane stripping.

Graded Aggregate Supplied to Contractors

The supplying to the contractors of graded aggregate for concrete by means of a central mixing plant and the District's standard gauge railway has been successfully carried forward by the Water District forces during the past two construction seasons. The supplying of properly-proportioned aggregate was more or less a new departure; and, as this material had to be delivered with regularity to fourteen different working points, located at set intervals along the route of the eight-five mile gravity aqueduct and as it also had to be of a quality that would give a uniformly watertight and economical concrete, it might reasonably appear that the difficulties of mixing, delivering, and placing it would prove insurmountable, but the miles of uniformly high class dense impermeable concrete in the thin walls of the completed portions of the aqueduct stand as a solid record of the success of the methods employed.

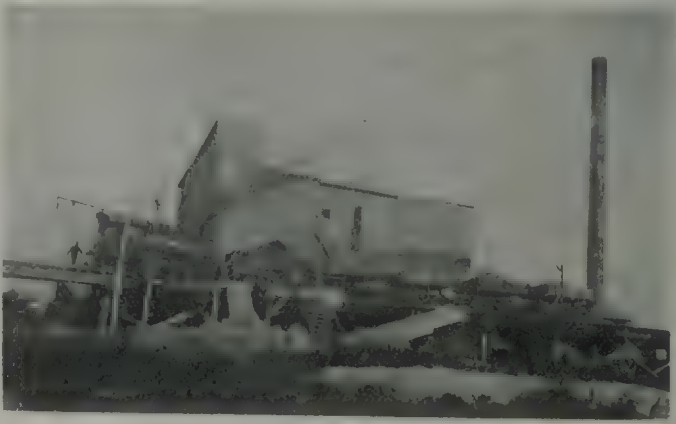

Fig. 5—Pit No. 1. Crushing, screening and mixing plant for manufacture of graded aggregate.

A gravel deposit at Mile 31 on the railway is the main source of supply for graded aggregate. The pit contains a large supply of gravel, with a well graded sand, considerable quantities of oversize, and at one end of it a deposit of very fine sand. It has a 25-foot face, with about 2 feet of stripping. A 15-ton Browning locomotive crane, equipped with a 1½ cubic yard bucket and a 42-foot boom, is used for stripping, loading fine sand, spotting cars, moving track, and as a spare for excavating. A No. 14 Bucyrus drag line, with a 2 cubic yard bucket and a 60-foot boom is used for excavating the gravel (see Fig. No. 4). This machine, operating from the top of the pit, has a great advantage over a steam shovel, in that it is able to leave clay or material high in sand right in the pit, and also because the cars serving it do not require to be operated up and down a steep grade into the pit bottom, as would be required for steam shovel operations.

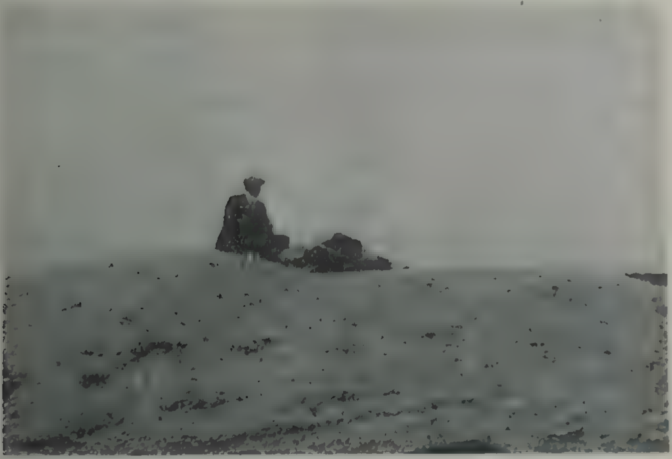

Fig. 6—Pit run gravel on contractor's platform.

Addition of Fine Sand Makes Up Deficiencies

In certain sections of the pit the sand is deficient in fine grains, and to material excavated from these sections fine sand is added by means of the crane. It loads up a number of cars of fine sand, which are dumped where the drag line is excavating, and the drag line runner then digs this fine sand in with the material he is loading.

The pit materials are excavated by the drag line, loaded into six cubic yard Western dump cars and hauled by a 19-ton steam dinky locomotive to the screening plant. (See Fig. No. 5.) Here the materials are dumped upon an inclined grizzly, with bars spaced to give three-inch clear openings. The oversize is fed by hand from this grizzly into a No. 4A gyratory crusher, and thence, after crushing, to the elevator, which carries the gravel from the grizzly hopper up to the screen, which has three sections, with openings respectively ⅜ in. x 1 in. long, 1½ in. diameter, and 2¼ in. diameter. The oversize is tailed to a No. 4 Champion jaw crusher and, after passing through it, is elevated back to the grizzly hopper.

The materials from the screens pass into three bins containing respectively sand, intermediate and coarse stones. From these bins the material is drawn through hoppers and chutes equipped with hand-regulating gates, to a mixing belt, which travels at the rate of 300 feet per minute. The mixing of the aggregate is done by three laborers, under the direction of a skilled inspector. First the material from the coarse bins comes upon the mixing belt, then the material from the intermediate bin comes on top of the coarse material, and last the sand comes on top of the other two materials.

Classification of Materials

For purposes of inspection the materials entering into the aggregate are classified:

Fine sand—Material passing No. 100 sieve.

Sand—Material passing ⅛ inch square opening.

Intermediate — Material passing ½-inch square opening and held on ⅛-inch square opening.

Coarse—Material passing 1½-inch square opening and held on ½ inch square opening.

Oversize — Material passing 2¼-inch diameter round hole and held on 1½ inch square opening.

The mixture for aggregate is kept within the following limits:

Fine sand—10 to 20 per cent. of the dry weight of sand.

Sand—32 to 40 per cent. of the dry weight of the aggregate, with 35 per cent. as objective.

Sand and intermediate—Not more than 70 per cent. by dry weight of aggregate.

Oversize—Not more than 25 per cent. by dry weight of the aggregate.

The aggregate is mixed at the rate of 90 cubic yards per hour, elevated and discharged direct into 20 cubic yard air dump cars, which are moved along by a car-puller and switched by the dinky or locomotive crane to storage tracks, ready to be made up into trains of 18 to 20 cars. A number of methods were tried to provide storage of the mixed aggregate in bins at the plant, but none of the methods used were able to accomplish the desired result at reasonable cost. The difficulty which has to be overcome before storage of mixed aggregate can be cheaply accomplished is the natural coning action of the gravel which unmixes the aggregate. Further segregation results as the material is drawn into cars from the bottom of the storage bins. Surplus storage may be provided on platforms at site of work, as is done on the G.W.W.D., or in large bins for the separate sizes of material.

Output of Plant

The maximum output of the plant for one day of two ten-hour shifts in the season of 1916 was 1,357 cubic yards of mixed aggregate and 160 yards of surplus sand. In 1915, 58,000 cubic yards of mixed aggregate and 30,000 cubic yards of other materials were supplied from this plant, and in 1916 some 130,000 cubic yards of aggregate and 12,000 cubic yards of other material.

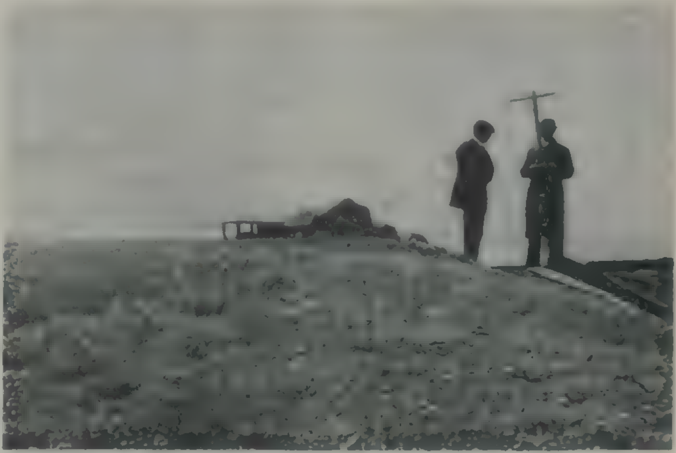

Fig. 7—Graded aggregate (after rain) on contractor's platform. Compare with Fig. 6.

For transporting the aggregate from the plant to the contractor's site of work the District standard gauge railway is used. As required from day to day, trains of 10 to 20 air dump cars of 20 cubic yard capacity are made up and hauled out to distribute the aggregate to the site of its use. In transport there is no segregation of the mixed aggregate, though a shrinkage in volume of 3 to 10 per cent. occurs. At each site of work plank platforms are provided by the contractors for the reception of the aggregate (see Figs. Nos. 6 and 7). When dumped upon the platform there is a tendency for a slight segregation to take place by the coarse material rolling away from the railway track. Such slight segregation is overcome by the contractor's men in loading the material for the mixers; they dig swaths in the pile of aggregate at right angles to the railway track.

The aggregate is sold to the contractors at 75 cents per cubic yard for sand and 75 cents per cubic yard for gravel delivered from cars at the site of work. The aggregate is measured at the plant, and the contractor is allowed 10 per cent. for shrinkage in transit, and pays on the basis of the yardage of the separated materials.

In order to meet the increased demand for material in 1916 a rock plant, a gravel pit, and a fine sand deposit located at the east end of the line were opened up. From these sources materials were delivered separately for a portion of the season to the three eastern working points. A direct comparison between separated and mixed aggregate was thus obtained at the same working points.

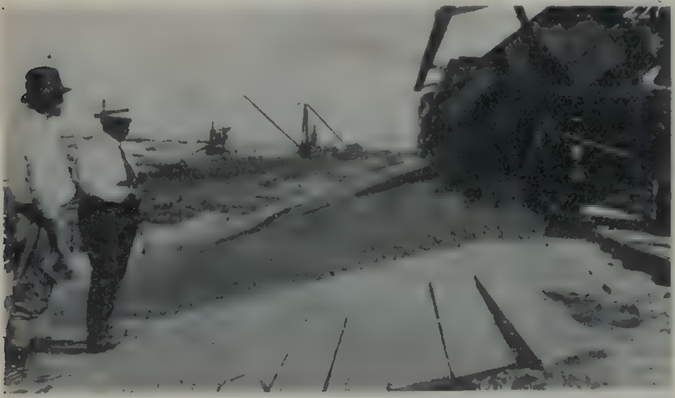

Fig. 8—20 cu. yd. air dump car placing graded aggregate on contractor's platform.

Results of Two Years' Experence

Two years' experience on the aqueduct construction with graded aggregate has shown the following results:

1. A dense, impermeable concrete, uniform at all working points.
2. A saving in cement quantities. The mixture at present used is 3 bags (87½ pounds gross each) of Portland cement to 18 cubic feet of loose, moist aggregate. This gives some 1.15 barrels, of 376 pounds, of cement to each cubic yard of set concrete. This mixture may be compared with 1:2:4 mixtures commonly specified and used for supposedly watertight work. The saving in using the Water District mixture over an ordinary 1:2:4 mixture with cement at $2.75 per barrel of 350 pounds delivered on site of work would amount to $350,000 on 400,000 cubic yards of concrete, the approximate quantity required for this water supply project.
3. At the pit only is it necessary to have inspectors trained in the proper proportioning of the materials.
4. Proper proportioning of all ingredients of the aggregate necessary for the desired watertight and economical concrete is possible only at the pit. The cost of mixing is only about 1 cent per cubic yard of aggregate.
5. A saving of one-eighth the number of cars which would be required for the delivery of sand and gravel separately. This item amounts to about $10,000.
6. The mixed aggregate is easier and cheaper for the contractor to handle than separated materials.

Matters of Interest to Engineers and Contractors Discussed at Montreal Builders' Exchange

WALTER J. Francis was the speaker at a luncheon of the Montreal Builders' Exchange, held on February 22. Mr. W. C. Munn presided, in the absence in New York of Mr. J. P. Anglin, the president. Mr. Francis' subject was "Mixed Pickles," a title covering a number of subjects of local and general interest. First of all, he referred to the efforts of engineers in connection with public questions, where they had placed their services at the disposal of the community. This was notably so at Calgary, when a controversy arose over the construction of an important bridge. The members of the Canadian Society of Civil Engineers offered their services, with the result that the controversy was satisfactorily settled. Another instance was that of Mr. W. F. Tye, who had compiled a paper dealing with the Canadian railway problem, which had cost months of work and a large amount of money, with a view to solving a problem of immense importance to the country.

Dealing with the Montreal building by-laws, Mr. Francis recalled the fact that it was just five years ago that he addressed the members of the Builders' Exchange on this subject, which was still awaiting settlement. The architects and builders desired a new code, and he was certain that Mr. Chausse, the building inspector, had done his best. It was the fault of the administration that no result had followed, and it was the fault of the citizens that the administration had not dealt with the subject.

The Montreal waterworks aqueduct was the third question touched on. The engineers, he said, had hammered away to get a commission appointed to inquire into this subject, but it was only recently that they had been successful. The ratepaying engineers had paid thousands of dollars in time in achieving this object.

Conservation Necessary

With regard to conservation, the builders could exercise a great influence on this question, which involved the use of native products. It was not conservation to permit jerry building; it was not conservation to allow fire traps when they could erect fireproof buildings. As citizens, they desired conservation of Canadian materials and of Canadian brains. Why should so many of our excellent young Canadians drift across the line when they could be used to better advantage here? It was found that men with excellent qualifications had gone across the border because Canada had not done anything to keep them here, and they were now urgently required.

On the question of alien engineers and contractors, the position he took up was—unless outside concerns became thoroughly Canadian and were prepared to bear their share of the war burdens they could not expect to stand shoulder to shoulder with Canadians. They should get advice where it could be best obtained, but when it came to Canadian contracts and especially Canadian government contracts, Canadian contractors and engineers should have the first call. Mr. Francis here referred to a petition to be presented to the government having reference to the employment of alien architects, engineers, and contractors on public works in Canada, and especially to the government arsenal at Lindsay.

The Quebec provincial law respecting the responsibility of architect, engineer, and contractor needed revision. The architect, engineer, and contractor were now responsible for a building for a period of ten years, but how, asked Mr. Francis, could a contractor be responsible for a modern structure and for details over which he had absolutely no control? If, for instance, a qualified engineer were called in to design a filtration plant, how could the contractor be fairly held to be liable? If in addition the designer was not a resident of this country, how was it possible to make him take his share of the responsibility?

The speaker then touched on the subject of preparedness, alluding to the memorial to the government prepared by Canadian engineers on this question. This had resulted in the appointment of the Research Commission, on which Montreal was represented by Mr. R. A. Ross and Mr. Surveyer. The Commission had taken up, amongst other matters, the subject of the utilization of lignite deposits in the West and the supply of domestic water in the West. The Commission were also working on the re-organization of the various government departments at Ottawa to prevent overlapping. That this was needed was shown by the fact that as many as four departments would practically go over the same ground in studying a subject. The matter of returned soldiers would have to be dealt with. After the war new conditions would obtain, and these must be met. Great advances had been made, arising out of the war, and in these Canada had done its part. Canada had adapted itself to war conditions in a way which no other country had done. The Dominion Bridge Company was an example of what could be accomplished—a falling away of business followed by a tremendous revival, and adaptation to meet the new conditions. Such examples were a tribute to Canadian energy and brains, and showed that we could adjust ourselves to emergencies.

Mr. Fraser S. Keith, New Secretary of Canadian Society of Civil Engineers

Professor C. H. McLeod, who has been secretary of the Canadian Society of Civil Engineers practically during the life of that organization, has resigned. Professor McLeod during all these years has carried on his work at McGill University in addition to that demanded of him in connection with the Canadian Society. The secretarial work has now reached such proportions, however, that Professor McLeod finds it impossible to give it the necessary time. The new secretary, Mr. Fraser S. Keith, will devote all his time to the work.

Advance Planning and Time Schedules Secure Rapidity and Economy

NEARLY all large buildings are erected according to some sort of time schedule. This schedule, in many cases, merely provides for completion within a stipulated time, and it is the duty of the various contractors to so plan their work as to fulfill this arrangement. Where rapidity and economy is desirable, some more definite system must be evolved and followed. One prominent construction company executes its many important contracts for large buildings under a prearranged time schedule, which provides for the commencement and completion of each item of the work at stated dates. Materials and supplies are delivered according to a similar time-table, and the arrangement is such as to prevent confliction of operations and delays in obtaining labor, work, or materials.

The table shown herewith is a typical schedule from the records of the company referred to, and shows exactly what is included, how the items are arranged and the date predetermined. This schedule, which applies

Progress Schedule.

Item.	Start.	Finish.
Clear site	Sept. 4	Sept. 16
General excavation	Sept. 11	Sept 20
Footing and foundation walls	Sept. 18	Oct 5
Rolling for paving	Sept. 14	Sept 25
Backfill and grading	Sept 20	Oct. 5
Driving piles	Sept. 14	Oct. 5
Test pits	Sept. 1	Sept. 16
CONCRETE.		
Footings and foundation walls	Sept. 20	Oct. 7
Paving	Sept. 28	Oct. 10
Floors and columns	Oct. 6	Nov. 23
Stairs	Oct. 28	Dec. 7
Sills and coping	Nov. 7	Dec. 12
Parapet	Nov. 18	Nov. 25
Pent house	Nov. 18	Nov. 25
Grano finish	Nov. 6	Dec. 9
Carborundum rub	Oct. 13	Dec. 5
Cinder crickets roof	Nov. 18	Nov. 30
Unload cement	Sept. 7	Nov. 22
Unload sand	Sept. 16	Nov. 22
Unload stone	Sept. 16	Dec. 5
Unload, erect, and dismantle plant	Sept. 2	Dec. 16
STEEL REINFORCING.		
Unload	Sept. 11	Oct. 14
Bend and place footings and walls	Sept 16	Oct. 7
Bend and place columns	Oct. 5	Nov. 22
Bend and place floor	Oct. 5	Nov. 22
Bend and place beams	Oct. 5	Nov 22
Bend and place miscellaneous	Oct. 5	Dec 15
FORMS.		
Footings and foundation walls	Sept. 16	Oct. 8
Make columns, floors and beams	Sept. 25	Oct. 11
Erect column	Oct. 6	Nov. 21
Erect floors and roof	Oct. 6	Nov. 21
Erect beams and slab	Oct. 6	Nov. 21
Erect wall beam	Oct. 6	Nov. 21
Erect parapet	Nov. 15	Nov. 29
Sills and coping	Nov. 6	Dec. 14
Stairs	Oct. 25	Dec. 14
Pent house	Nov. 15	Nov. 25
Unload lumber	Sept. 5	Oct. 5
Strip columns	Oct. 13	Nov. 25
Strip slabs	Oct 18	Dec. 5
Steel sash—unload	Nov. 6	Nov. 18
Steel sash—erect	Nov. 7	Dec 12
Steel sash—grout	Nov. 8	Dec. 16
MASONRY.		
Unload brick and tile	Oct. 16	Nov. 30
Lay tile	Oct. 30	Dec. 9
Lay brick	Oct. 25	Dec. 9
Staging and plant	Oct 20	Dec. 13
Plastering	Nov. 6	Dec. 20
Door frames, guards, and sills	Oct. 25	Dec. 10
Doors and hardware	Nov. 15	Dec. 16
Inserts	Oct. 9	Nov. 25
Sleeves	Oct. 9	Nov. 25
Scuppers	Oct. 9	Nov 25
Miscellaneous iron work	Oct. 15	Dec. 15
Wood partitions	Nov. 15	Dec. 15
Clean up job	Dec. 21	Dec 30
Watchman	Sept. 14	Dec. 30
Overhead	Aug. 30	Dec. 30
SUB-CONRACTS.		
Painting	Nov 6	Dec 30
Glazing	Nov 10	Dec. 18
Plumbing	Oct. 9	Dec. 30
Sprinklers, piping, interior	Oct 23	Dec. 23
Mains, exterior	Sept 15	Oct. 15
Electric wiring and conduits	Oct 9	Dec. 23
Roofing	Nov. 22	Dec 23
Heating	Oct 16	Dec 13
Elevators	Nov. 15	Dec. 23

Continued on page 185)

Pneumatic Caisson Work on the Piers of the Petitcodiac River Bridge at Moncton, N.B.

By E. M. Archibald, A. M. Can. Soc. C. E.

THE Petitcodiac River is situated at the northern extremity of the Bay of Fundy, and in this neighborhood there occur the highest tides in the world, the government records showing a rise of 45 feet at spring tides. At the City of Moncton, located on the Petitcodiac River, some twenty miles from its mouth, and at the head of navigation, the rise of tide is only 30 feet, owing to the higher level of the river at that point. Here, at each incoming tide, appears the "bore," a tidal wae due to the onrushing water crowding into the ever-narrowing channels of the river. The bore, although appearing at other points on the Bay of Fundy, is at its highest at Moncton, and is most readily seen from that point. This bore varies in height from a few inches to at least four feet—many claim six feet—depending on the stage of tide and velocity of the wind.

Historical

Directly opposite Moncton is a populous farming country, and after long, unsuccessful endeavors to have a highway bridge built by the government, these farmers, resolutely and at great sacrifice, raised enough money to start work on the piers for a bridge, and managed to keep the project going, until, after two years' work, a bridge was in existence. This was in the year 1869.

Old-timers tell of the difficulties in placing the wooden cribs forming the piers; how one after another broke lose from the moorings and were swept away by the swift current, and how eventually the piers were completed, wooden spans constructed on shore and floated out on scows into place—altogether an undertaking of no mean engineering ability. Somewhere about this period the provincial government were brought to a realization of their responsibility, and bought the bridge.

Unfortunately, its benefits were not long enjoyed, for in the autumn of 1869 what is known as the Saxby gale occurred, causing great havoc to shipping and to property, and in the tremendous tide that ensued the superstructure was washed away and the piers scoured so much that they settled from eight-to ten feet in a few cases. However, reconstruction was proceeded with, the piers added to, and the superstructure rebuilt. After about twenty years' service the superstructure was again renewed. At the present time the existing superstructure is approximately twenty-years old, and has been in urgent need of renewal for several years. The life of the old piers, now nearly fifty years old, is past.

About ten years ago natural gas was discovered at Hillsboro, and, in order to reach the nearest market in Moncton, the mains had to cross the Petitcodiac River. A 10-inch gas main was added to the loading of the old bridge, carried by projecting brackets. Several attempts have been made to lay a gas main in the bed of the river; but without any success. The old bridge continues to be the weak link in the transportation of this very necessary feature to the domestic and commercial life of Moncton.

Location of New Bridge.

The location of the new bridge is 33 feet up river from the centre line of the old bridge. In considering the location for a complete new bridge the provincial engineer, Mr. A. R. Wetmore, decided to keep as close as possible to the old bridge, for two reasons—(1) financial, in that the old structure would be of very great service in the erection of the new bridge; (2) soundings showed a ridge of rock closer to the surface of the water at this location than for some considerable distance either up or down river. On the other hand, it was very necessary not to undermine the existing foundations of the old piers. The adoption of the pneumatic system of sinking caissons was decided upon as the least dangerous to the old piers.

River Conditions.

Working conditions in the Petitcodiac River are particularly severe. There is the bore already referred to, the high tides, the high velocity of the current, but perhaps the most discouraging feature is the muddy condition of the water, due to the tide sweeping over the extensive mud flats, picking up the mud or silt, carrying it in suspension and depositing it in eddies and at high and low water intervals. The velocity of the current reaches ten miles an hour at half tide on what are known as spring tides, occurring for a week at each full and new moon periods. At neap tides, occurring during the first and last quarters, the tide gradually falls to as low as twenty feet rise, and the current diminishes correspondingly. This rise of tide occurs in a period of three hours, then there is a lull of twenty minutes at high water before the tide falls perceptibly, after which it recedes very rapidly for three and a half hours, then more slowly. There remains a period of about four hours at slack low water for sub-aqueous work before the arrival of the next succeeding tide.

Another very annoying condition was the rapid shifting of the channel below the bridge site, caused at times by very high winds and at other times by a freshet or heavy run-off of fresh water, carrying tremendous quantities of mud in suspension from the upper reaches of the river and deposited on the flats, causing a bar to build up, and thereby prevent the water from running off. A rise in low-tide elevation of as much as 42 inches was observed from this cause.

Ordinary soundings showed from six inches to eight feet of silt on the bottom, below which the material was so firm and compact that an ordinary sounding bar could not penetrate it.

Construction Equipment.

In considering the method to be adopted for construction of the sub-structures the weakness of the old bridge and piers and the fear that it would be swept entirely away by the severe ice conditions existing in the winter and early spring, together with the large amount of traffic passing over it, led to the decision to use a cable-way spanning the river, and derricks at each pier for handling all material. It was estimated that the largest block of granite required in any pier would not exceed four tons, and that this would probably be the maximum load to be carried on the cable-

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* Before the Canadian Society of Civil Engineers.

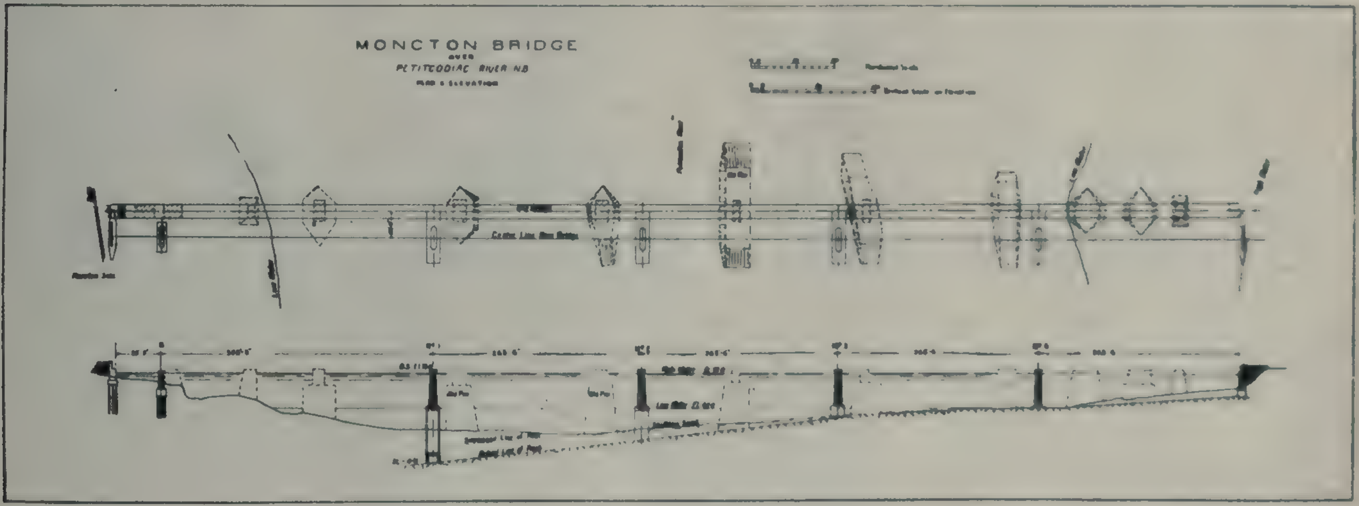
way, but to provide for emergencies it was designed for a maximum load of six tons. To allow a sufficient factor of safety for the long span of 1,600 feet between towers a 2-in. carrying cable was advisable, but as the contractors had in stock a 1¾-in. cable, 1,620 ft. long, it was decided to use it and reduce the working strain in the cable by building higher towers and allowing a heavier sag in the cable. The cable as installed, measures 1,591 ft. between towers, and can be adjusted for a minimum sag of 60 ft. The cable in stock was short by about 200 feet of the length required to span the river and over the towers to the anchorages. This was overcome by splicing short pieces to each end, the connection being made by drop-forged sockets. The anchorages were made by excavating to depth of six feet in the ground, twenty feet wide and twenty feet long, building a crib platform carrying one hundred tons of stone for ballast, the main cable being carried to the bottom and around a very large birch log. A turnbuckle at one end provides for taking up about six feet of slack in the cable. The tower on the Moncton side is ninety feet high, and has a base of twenty-three feet wide by thirty feet lengthways of the cable. The front legs of the tower are set on a batter of one in five, which falls within the resultant of the forces acting on the tower. The tower on the Albert County side of the river is on a higher elevation, and in consequence was only built eighty-five feet high. The centre line of the cable was located fourteen feet up river from the centre line of the new bridge. The stringing of the main cable across the river presented a problem of itself, as it was necessary to keep the cable out of the swiftly-running current of the river, which, with the maximum sag permissible, and with the weight of this main cable, required the strength of the supporting wire to be fourteen tons during erection. This was solved by using the two ⅝-in. wire ropes, later used for the hauling cable, as a carrier for supporting the weight of the main cable, this main cable having snatchblocks wired to it every 200 feet, which travelled along on the two supporting wires. The cable-way outfit is a Flory design, the engine having two 8½ x 12 cylinders, link motion, and two 42-in. drums. The hoisting and hauling ropes are each ⅝-in. diameter wire rope.

All materials are brought in by rail, the I.C.R. yard being only half a mile from the site of the bridge. The contractors put in a spur line and used a 35-ton locomotive. A difference in level of 22 feet existed between the railway yard and site of the bridge. A trestle having a 6 per cent. grade and a 14 degree curve was erected, the grade favoring the load. At the site of the work one siding was put in for granite storage and another for gravel storage, the latter being approached by a trestle with a rising grade of 6 per cent., up which one car of gravel was run at a time. The gravel storage has a capacity of 1,000 yards.

For mixing concrete a battery of two ½-yard Smith mixers was used, located directly under the cable-way. Gravel was shoveled into ½-yard cars at the storage pile, cement added to make the required batch, and the whole hauled up an incline to the mixer platform.

Two 40 h.p. locomotive boilers were used for the first year's operations, previous to the installation of the pneumatic plant. Two hundred and twenty additional boiler horse power was added later, to take care of the pneumatic work.

The compressor plant was located immediately alongside the boiler plant, and consisted of one 1,150-ft. Ingersoll Rand compressor, 18 x 24¼ x 24, and a second of 1,250 cubic feet capacity, with cylinders of 24 x 24¼ x 30. The air, after being compressed, passed into a 42 in. x 14 in. receiver, thence by two lines of 4-in. pipe, located along the old bridge, to the work. A derrick car was used in the granite storage yard for unloading the granite from incoming cars and afterwards reloading on small cars running to a point directly under the cable-way, whence it could be picked up and carried to the pier under construction.



Plan and elevation of bridge over Petitcodiac River, showing location of old and new structures.

The floating plant consisted of one frame derrick scow, 60 x 25; one 68 x 28, and three 45 x 16, all with flush decks. This floating plant was seldom used on account of difficulty of handling in this turbulent river.

Water obtained from the city water supply was carried through 1,200 feet of 2-in. pipe to the boilers and mixers and a 1-in. pipe line extension to the different piers under construction.

Construction Work.

The north abutment was excavated about six feet below the surface of the ground, after which piles were driven and the concrete poured directly from the mixers. This abutment was above high tide.

Pier B was foundationed on piling 10 ft. above low water mark, the excavation being sheet piling. The only difficulty encountered here was due to the heavy sediment deposited by each tide, which had to be scoured off before concreting could be continued.

The excavation for the south abutment was carried to rock, which was reached 12 ft. above ordinary low water mark. The excavation was sheet-piled to prevent the banks falling in when the tide filled the excavation. A concrete footing course 6 ft. thick was poured, and the granite then started. No difficulties were encountered with this pier.

No. 4 Pier was founded on rock at extreme low water mark, the rock being levelled off at slack water periods to a level 6 in. below extreme low tide. A grillage 30 in. thick was accurately placed on this levelled-off bottom, forming a footing for the granite pier. No great difficulties were met with in the erection of this pier, except for the precautions to prevent the tide washing away the green concrete hearting. Tarpaulins were used for this purpose, covering the entire work, and being roped down solidly to the birch grillage just before the arrival of the bore. Notwithstanding all precautions taken, a small quantity of the concrete hearting would be washed away and a deposit of mud left by the tide, which would have to be scoured off before pouring any more concrete. To give some idea of the force of the current at this pier it may be mentioned that granite blocks placed on top of the tarpaulin to hold it down were displaced by the current, and in one instance several granite blocks, containing as much as a yard apiece, were washed clear off the pier.

When taking soundings at the location for No. 3 pier it was found that the bottom was scoured clean to the rock and was only five feet below low water for over half the length of the pier at its centre, but dipped to a depth of nine feet at both up-stream and downstream ends of the pier. It had been the intention to use the pneumatic system in foundationing this pier, but, as a result of these soundings, it was decided to build an open caisson, with the sides fitting the bottom, and with a puddle chamber on the outside, so that the water could be pumped out and the rock cleaned before concreting. This caisson was built on shore, with a puddle chamber 2½ ft. wide surrounding it. Just previous to high tide it was launched, towed to its position, and moored through the ebb tide. Towards the end of the ebb tide it was placed accurately in position and ballasted with rails. The puddle, consisting of clay and gravel, was placed in the puddle chamber and completely covered with gravel in bags, to prevent scour by the tide. Just when ready to start pumping operations a period of heavy rains came on, bringing down with the fresh water large quantities of silt, which deposited on the bars in the river and caused a rise of 3½ ft. in low tide elevation, and this rise of water caused endless trouble, since the puddle chamber had not been designed for so much pressure, and, when pumped out, it would blow repeatedly. Fortunately, the caisson had been bulk-headed into four water-tight sections. Pumps were placed in one section at a time at the early part of low water period, and by pumping each compartment separately the bottom was cleaned of sediment and concreting carried on at low tide intervals. Several tides were required to fill each compartment on account of the delays caused by cleaning operations at each tide. A tarpaulin was battened down on top of the green concrete at the completion of each tide's operations, to prevent scour.

Concrete was stopped two feet below low tide mark, after which three feet of hardwood timber grillage was used to form a footing for the granite pier.

The work already described was performed from the time operations started in July, 1915, to the end of the same year.

Pneumatic Caissons.

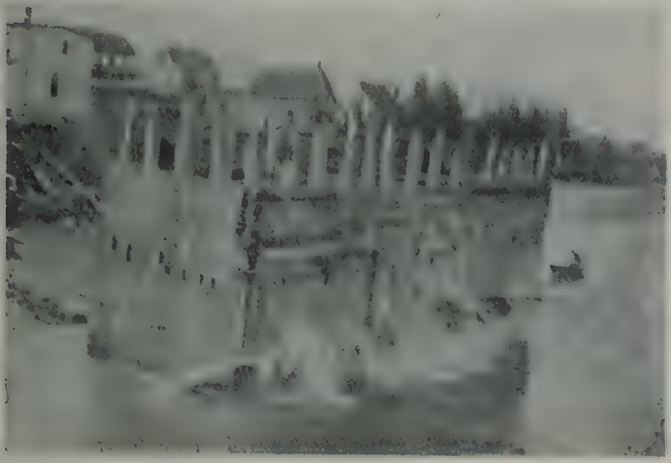
Conditions at the site made it necessary to build and launch the caissons on the Albert side of the river, although this was on the wrong side for ease of handling material. Blocking was set up and the caissons built "side on" to the river, one caisson behind the other, but both within reach of one derrick and the cable-way.

The responsibility for the design of the caissons was entirely in the hands of the contractors, except for the outside dimensions. Further, the engineer's requirements, that no concrete be deposited through water, in addition to the launching and holding problems, presented a set of conditions none too easy of solution. To fulfil the first requirement, the caisson was divided into three parts, with two water-tight bulkheads, so that any one compartment could be pumped out and concrete deposited in the dry space during low tide periods. This shortened the time of pumping and permitted longer time for concreting, and also reduced the buoyancy, as only sufficient weight was necessary to overcome the displacement of the pumped-out chamber and the natural buoyancy of the caisson.

No. 1 caisson, as launched, was built 18 ft. 9 in. high, with 18 in. of concrete on the roof of the air chamber, floated 13 ft. 6 in. deep, and weighed 370 tons. At the time of launching, three-quarters of an hour before high tide, there was only 15 feet of water available at the end of the launchways. The intention was to launch early enough before high water to permit the caisson to be towed to place and the moorings secured before the turn of the tide, then to place enough timber on the top of the caisson so that when sunk in place the top of the caisson would be above low water. Intentions are not always carried out, and it proved so in this case, for the launching was not successful. The caisson slid off the ways sideways just after starting. However, after jacking up, the above programme was followed. The caisson was launched successfully, towed across the river, moored, and several courses of timber placed. The moorings held through one ebb and one flood tide, but parted at about half ebb the second day. Owing to the first attempt at launching having proved unsuccessful, the second launching was thrown forward into a period of the highest spring tides, when the velocity of current was greatest. However, since the current at the location of No. 1 pier from our observations had never shown as much velocity as at No. 2 pier, on which all the calculations were based, it was decided to proceed with the placing of the caisson. The first tide having been passed through without any trouble developing, it was thought all danger was past. On the second ebb tide, however, after the heaviest run had appeared to be over, a species of tidal wave occurred, which was deflected straight across the river, when it reached the old piers and caught the caisson broadside on with a heavy surge, parted the breast-lines, then snapped the heavy mooring cables like pipestems. The men on the caisson jumped for their lives to the scows moored alongside, then to the boats, and followed the wreck down stream. The caisson grounded on a mud flat about six hundred feet below the bridge and partially rolled over, enough to expose one cutting edge at low tide. Here she lay the sand scouring until she had enough bearing to carry, but resting in a hole in the sand eighteen feet deep, and sand banked up to the water's edge within thirty feet of the caisson. How, after rolling over several times, she was finally floated and brought back to place, might be interesting, but the author can assure you it was just a succession of difficulties, not the least of which was the continued rainy weather. Simply, it consisted of righting the caisson and holding until she could be pumped out and nursed into a convenient place for handling.

Caisson Design.

In view of the fact that the probabilities were that the bearing under the cutting edge would be very uneven, and that the caissons would be subjected to very severe conditions, it was decided to make the design very rigid—much more than the known stresses would warrant. That this decision was prudent it may be mentioned that the one caisson which went adrift and was tossed around on the mud flats was in perfect condition when finally placed in position. The only damage was the breaking of the 12 x 12 cross-struts inside the air chamber; these were readily renewed after air had been applied.



Caisson being launched

Starting from the bottom of the caisson, we first find a 9 in. x ⅝ in. flat plate bolted to the lower timbers and forming a shoe for the cutting edge, which was formed out of an 8 x 16 hardwood timber, bevelled off on the inside. On this were laid the 12 x 12 hard pine timbers, forming the outer wall of the air chamber. The inner wall consisted of 12 x 12 vertical timbers, securely screw and drift-bolted to the outer timber with 1-in. iron in all cases, and large plate washers under both head and nut. Every fourth vertical timber passed up through the roof and continued well up to low water elevation on the inside of the cofferdam, as we shall call the portion of the caisson above the roof of the air chamber. By means of 1-in. screw bolts every two feet into the outer walls, this upright timber increased the rigidity and further prevented the tendency of the various timbers to pull apart under displacement when the cofferdam was pumped out.

The roof of the air chamber consisted of two tiers of 12 x 12 hard pine timbers, placed transversely and with staggered joints. Great care was observed in securing tight joints everywhere, but more especially when the verticals passed through this roof, since there was the greatest danger of air leakage when under pressure. Heavy single-ply roofing paper was laid between the two tiers of the roof, and all joints well pitched, as a further precaution against leakage. Each roof timber was side-bolted to its neighbor with three 1-in. drift bolts.

Eighteen inches of 1:2:4 concrete, reinforced with 1-in. rods spaced 12 in. apart, both longitudinally and transversely, was poured on top of the timber roof for additional strength and incidentally to further prevent air leakage. Another very important feature of this concrete roof was that it served the purpose of keeping the centre of gravity as low as possible, resulting in greater stability while afloat.

The weak point in a caisson is the junction of the air chamber with the cofferdam above the roof. We consider that the method adopted strengthened our work very materially. This consists in a 12 x 12 waling timber immediately under the roof and another on top of the concrete roof, bolted every two feet in each direction.

Six 12 x 12 hard pine struts were placed inside the working chamber as close to the cutting edge as feasible to resist the inward pressure, and six 1½-in. rods, used to resist any possible outward pressure. In ordinary cases these rods are of doubtful value, but may have been of some benefit in the case of the caisson which went adrift.

Heavy roofing paper was placed between the two tiers of timber in the side walls of the air chamber, as well as in the roof, to prevent air leakage.

The air chamber was sheathed inside and outside and on the bottom of the roof with 3-in. planed hardwood sheathing, with caulked joints. Two threads of oakum were driven in all joints in the air chamber, and well pitched. All horizontal timbers were drift-bolted with 1-in. drift bolts 20 in. long, every four feet.

The cofferdam consisted of a single wall of 12 x 12 timber hard pine or yellow birch, half dovetailed at corners, and drift-bolted every four feet. Six sets of 12 x 12 timbers served as transverse ties for the outer walls, the ends being dovetailed in, and one set of longitudinals served the same purpose. At intersections these ties were screw-bolted together.

The cofferdam was divided into three compartments for convenience in pumping, as previously explained. Both below and above the bulkheads the concrete was poured in a monolithic mass. The walls of each compartment were pierced with four 4-in. holes, through which was passed a 4-in. pipe with an elbow and seven foot length of pipe on the inside of the caisson, forming a swinging joint to control the inlet of water for slowly flooding the caisson after concreting when each tide's work was completed. This stopped the green concrete from scouring when the incoming tide boiled over from the top of the cofferdam.

The air chamber roof was pierced with three 36-in. shafts, one being a man-shaft, located in the centre of the caisson; the other two for material, one at each end and spaced to handle material with a minimum of handling.

Air was supplied through two 4-in. pipes located at opposite ends of the caisson. Two more 4-in. pipes through the roof were used as blowpipes for blowing water and sand from the air chamber. A 1-in. whistle pipe was used at each material shaft, for signalling purposes. Two 1¼-in. pipes were installed for supplying fresh water to the air chamber, but were not used for this purpose. They, however, served for supplying compressed air for pneumatic drills used in drilling boulders. Electric lights were used on removable leads run through the man-shaft, but were removed at the end of each low-tide shaft.

Launching

Both caissons were launched sideways about three-quarters of an hour before high water. Four 12 x 12 launchways were used, set at a slope of one in ten. Had the slope of the beach warranted it, a lesser slope would have been better. Four 12 x 12 running-ways were placed under the caisson, resting on the launchway; each running-way had a 6 x 12 board bolted on for a guide. All four running ways were roped fast to the launchway at the shore side of the caisson and ropes cut simultaneously when ready to launch. In order to check one end going faster than the other, timber dogs were used, with one end made fast to the running-way and the other ready to drive into the launchway should one end of the caisson start before the other. In addition, a four-part rope tackle was used at each end, with the end passing round a snubbing post. With these preventatives and a crew trained to work together there appeared to be no difficulty in getting the caisson started properly, but after taking water and before becoming water-borne the caisson in two cases gradually swung off the ways up-river in the direction of the river current, indicating that the slight current exerted enough pressure to make the launching a failure. Had launching been attempted at high tide, still water, there seems no reason to doubt its success, but as there is only about twenty minutes of still water, no time would have remained to tow and moor. In one case the caisson, after dropping off the running ways, became water-borne a sufficient time before high water to tow it across to place and secure the moorings, but in the other case it was necessary to wait a few days for a high tide enough to float. Tallow was used on the launchways as a lubricant. The outer ends of the running-ways were weighted with rails to clear them from the caisson when afloat.

Towing

A 35-ton dinkey, used in switching operations, was used to tow the caisson to position. A 1⅛-in. steel cable 1,600 ft. long, was stretched across the river previous to launching, passing through a heavy snatch block on a scow, which carried the permanent moorings. The slack of the cable was kept off the bottom of the river by passing over another scow. After launching, the cable was attached to the caisson, and the dinkey started towing, until the caisson was brought into position alongside the mooring scow, where the moorings were quickly transferred from the scow to the caisson.

Moorings

The formulae used in calculating the moorings was:
$P = WK\,V^2/2g$, where:
W equals weight of water per cubic foot—65.
K equals constant (1.47 for square-ended caisson).
V equals current in miles per hour.
P equals pressure in pounds per square foot exposed surface normal to the current.

Current records taken with a ship's log showed a velocity of 9 knots per hour at spring tides and 6 knots per hour on neaps. These calculations showed a maximum strain of 26 tons had to be taken care of in moorings and two 1⅛-in. wire cables were used up river, one attached to a rock-filled crib in the river and the other to a dead-man on shore. The down stream mooring was a single 1⅛-in. wire cable from a rock-filled crib in the river, and a second 1⅛-in. cable fastened around the old pier adjacent to the final position for the caisson. A socket was attached to the end of each cable, and to this a five-part tackle of ¾-in. wire cable was hitched, running through 14-in. diamond blocks, the free end passing around one of the cross-timbers inside the caisson, where it could readily be payed out.

All upstream moorings were carried to a bridle fastened in the end of the caisson. The bridle consisted of four 1⅛-in. wire cables fastened at one end through 1½-in. eye bolts into the caisson, and all hitched together to a common shackle at the other end. In addition to up and down-stream moorings, four breast-lines were used at each corner of the caisson, consisting of four parts of 4-in. circumference rope through double blocks for adjusting the position sideways. A framework was built out from the old wooden pier on the line of the new pier, to which the caisson was breasted hard and used as a guide in sinking.

Sinking

An endeavor was made to level the pier sites by blasting out high spots and filling low spots with small stone, but was not attended with any great degree of success on account of the scouring action of the current. Soundings taken at No. 1 pier showed hard and soft spots alternately, and when the caisson was finally sunk, it was out of level as much as three feet and bearing very unevenly. A diver was sent down to try and obtain a more even bearing under the caisson, but very little success attended these efforts. Meanwhile pumping out and concreting was proceeded with, until sufficient weight had been put on to keep the caisson from floating when under enough pressure to enable the sand-hogs to go to work levelling up. The locks were installed and eight pounds of air pressure put on at low tide, driving out the water from the air chamber and enabling the man to start work. The entire upper end of the caisson was found open to the action of the tide, the opening being as much as three feet. After finally getting the caisson on a fairly even keel, concreting the top was proceeded with, until the right elevation was reached to correspond with the diamond drill borings. Two courses of granite were added, after which old car wheels were used for additional ballast. These were used instead of blocks of granite which were to be used in erecting the shaft of the pier, on account of their greater specific gravity, reducing the top-heaviness of the caisson. Even at that, it was necessary to pile up car wheels to a height of over twelve feet, and to indicate how little excess weight there was may be mentioned the fact that it was necessary to reduce the air pressure eight to ten pounds, even after the cutting edge was cleared, before the caisson would sink. Skin friction was found to run

Caisson under air pressure during sinking operations somewhat over 500 pounds per square foot, the nature of the strata being largely fine sand. As a precaution against overturning two 1⅛-in. wire cables were used as a strap around the caisson to the old pier.

It is in order to state that the air work was only carried on at low tide periods. Air was turned on while the tide had still six feet to fall, and the men were called out on the arrival of the bore, permitting six hours' work each tide.

This decision as to low-tide work was due to the narrowness of the caisson compared to its height. No. 1 caisson being only 18 ft. wide and the height from the natural ground surface of the river bottom to high water was 50 ft., the distance from ledge rock as found at No. 1 to high water was 77 ft. Car wheel ballast to withstand the air pressure for working at any stage of the tide would have reached well above high-tide mark and made the caisson verv top-heavy and in great danger of of overturning in the heavy broadside current which prevailed at No. 1.

No difficulty was experienced in quickly blowing the water out of the air chamber with air pressure, until a heavy strata of clay was reached, which effectively sealed it, after which it was necessary to use the blowpipes to remove the water.

One of the many difficulties encountered, and which caused serious delay, was the entrance of quicksand into the air chamber on spring tides. This sand carried up on the flood tide, filtered through as much as 20 feet of cover before getting under the cutting edge, and would often fill the air chamber to within 18 inches of the roof. No means was ever found of wholly getting rid of this trouble; it would gradually disappear after the high spring tides were over, but since these high tides reappear at both full and new moon periods, it can readily be understood what a discouraging feature it was. The average rate per day of sinking No. 1 and No. 2 caissons was 6 and 4.7 inches respectively.

The slow progress in sinking No. 2 was accounted for by the fact that the material was boulders of all sizes, embedded in sand and clay. It was necessary to shoot these boulders constantly to clear them from beneath the cutting edge and to cut them down small enough to pass through the locks. No serious difficulties were encountered in sealing the air chambers.

There were no fatalities in this caisson work, and, in fact, throughout the entire work—a rather remarkable showing on a dangerous river. There were several cases of "bends," in which it was necessary to resort to the hospital lock. The air supply was ample for the work, although on a few occasions both machines were operating at capacity.

After the sealing up of the caisson on solid rock the car wheel ballast was removed, the top of the concrete cleaned off, levelled up to a uniform bearing at elevation 39.25, and the granite shaft started. Pumping operations were, of course, necessary each tide, since the granite footing course was 2 ft. 9 in. below dead low tide, and progress was slow. Only a small section could be attempted each tide on account of the short time available and the enormous amount of cleaning. Granite was laid in each section and hearted up with 1:3:6 concrete. There was 315 cubic yards of granite facing and 300 cubic yards of concrete hearting to each shaft. For protecting the green concrete against scour, wooden shutters were used in sections, secured with rods down the side of the granite shaft to the timber caisson. The heavy current was very severe on these shutters frequently upending them and breaking them in pieces wherever the slightest opening appeared, allowing the tide to get under them. This scheme, however, was the most successful for preventing scour of any used.

The above piers were built for the New Brunswick Government by Mr. A. R. Wetmore, provincial engineer; Mr. R. A. Malloy, assistant engineer on the work.

The contractors were Engineers and Contractors, Ltd., Mr. E. R. Reid, president, and the author chief engineer.

Advance Planning and Time Schedules

(Continued from page 179)

to a recently-completed factory, was published in advance, so confident were the contractors that its plan could be carried out. In the progress schedule are listed all the numerous detailed operations essential to the construction of the building and the dates upon which work is to start and cease in order to secure progress along the desired lines. The schedule is prepared after a complete study of the specific building, taking into consideration its size, location, character, special requirements, equipment, principal features of design and construction, and a thorough study of the labor and material market. It thus becomes the backbone of the job, and furnishes a standard to which both the outside and inside forces endeavor to conform as closely as possible. Whenever developments arise that materially change conditions, corresponding revision of the schedule is made.

Schedule of Materials for Purchase.

In order to insure proper delivery of all supplies required for construction, a schedule of materials for purchase is drawn up, in which are classified the quantities taken from the design and required by the bills of material, in alphabetical order, according to their commercial character. Detailed lists corresponding with the subject supplement this schedule, of course. In this table are enumerated all the materials, supplies, and equipment that are required for the building's erection and for the installation of such service as may be included in the contract. The table gives complete information as to the purchaser of the materials listed therein, the dates upon which they must be supplied, and any other detailed information in regard to delivery, etc. From the information contained in this schedule timely action can be taken to prevent delay in delivery. By the use of this system a large number of jobs can be very rapidly reviewed in the main office, so that the general superintendent and principal officials can determine at a glance whether the work is in a satisfactory condition, and, if not, what portions of it require special attention.

This advance preparation, followed by careful application of the system, together with a well-organized staff of experienced superintendents, engineers, designers, inspectors, and estimators, enables this company to carry out large contracts rapidly, accurately, and economically, in a manner that could not be obtained without such special control of operations.

A check on irregularities, deficiencies, and exigencies was afforded by this preliminary analysis of the work and its arrangement in exact sequence. The progress of the work is thus easily and accurately controlled from headquarters, and the exact condition of affairs can be determined and the effect of unexpected contingencies can be observed from the reports of the men on the job by comparison with the predetermined progress schedule.

Best Practice in Road Construction and Maintenance Discussed at American Road Builders' Convention

Concrete Roads

By H. E. Breed*

GRADES are still treated differently in different sections of the country. In some places grades as high as 8 per cent. are used, under certain conditions. Grade seems to be limited only by the ability of the wet concrete to run during the process of construction, by the character of the mix, and the kind of traffic to use it. Even on a steep grade the use of a coarse sand prevents the road from being slippery, and brooming of the surface facilitates the traction hold of all classes of traffic. Floating should be at a minimum, as this operation brings the finer particles to the surface, which gives a smooth top.

Width.

For two lines of traffic on a concrete road 18 feet should be the minimum width; for three lines 24 feet. The use of motor vehicles is steadily increasing; they are being built wider and wider. Hence they require pavements where vehicles at least 90 inches wide can constantly and comfortably pass one another. Eighteen feet is probably the narrowest width to allow this. Especially is this true of concrete roads, because the transition from the hard concrete surface to the earth shoulder and back again becomes really dangerous in some soils on account of the rut that traffic usually wears along the joining line.

Square-cornered Edges.

In design the edge of the concrete slab next to the shoulder should be vertical and square cornered. Then if it becomes necessary to reinforce the shoulder with road metal a good joint can be made; and, more important still, if additional widening is required, it can be accomplished with a longitudinal joint of minimum size. We have very satisfactorily widened some miles of concrete roads built in accordance with this design by adding four feet or more to one or both sides of the pavement.

Where the soil for the shoulders is unstable we are intrenching it with crushed stone or gravel four to six inches deep and one and one-half to three feet wide. Although this gives good results, and makes for additional safety, still, if much traffic must be turned onto them, the maintenance cost of these stone and gravel shoulders is so high as to justify the additional first cost of a wider pavement.

In order to obviate the danger of accidents on our 16-foot roads we have been widening or mooning out the curves, so that in some cases for those of small radius at the centre the actual curve is as much as 22 to 24 feet wide. We have also considered it good practice to give the outside of these curves a superelevation in order to make easier the steering of a car, to lessen the likelihood of skidding, and to insure greater safety in taking these curves at speed.

Essentials of a Good Subgrade

Cracking of a concrete pavement is due generally to the unequal settlement of a poor subgrade. If the road is to be satisfactory it is of first importance that a good subgrade be secured. These we consider the essentials of a good subgrade:

1. It must have uniform bearing power. If an old roadbed is to be used it must be scarified, reshaped, and rerolled for the entire width of the pavement, removing all large stone to a depth of six inches.

2. It must be dry. Ditches should be low enough to take away the water from under the pavement. With unstable soil good results can be secured by providing sub-drains and spreading a layer of gravel—preferably run-of-bank gravel—over the subgrade to increase its stability. Material used for this purpose must be impervious; if it is porous it will act during wet periods as a reservoir, which, under conditions of frost, will break the pavement proper.

3. It should have metal reinforcement (a) under very bad, i.e., unequal soil conditions; (b) whenever the supporting power of the subgrade changes, as from rock to earth, or passing over a trench.

Our experience indicates that the expense of reinforcement is not justified in gravelly or sandy soils where good natural drainage prevails.

The Mix.

The mix should be proportioned in such a manner as to give the greatest density. With our requirements for materials we have found that the proportions of 1:1½:3 most nearly do this. Our specifications provide that the concrete shall be mixed in the proportions of one volume of cement to four and one-half volumes of sand and broken stone or gravel, and the proportions of fine and coarse aggregate are varied slightly as a result of field void tests, so that the greatest density is obtained. Should the size or character of the materials change there would be a corresponding change in the proportioning of the mixture.

We allow, as our maximum size, stone that will pass a 2¾-inch ring, whereas most specifications permit only 1½-inch stone as a maximum. This may seem radical, but our reason for the increase in size is that we get equally as good, if not better, results from the larger stone, and at a cost decidedly lessened by our using more nearly the product of the crusher.

Importance of Tests

Tests for concrete materials have never been given their proper consideration, with the exception of cement which has been tested with all the finesse of the art of testing. In general little, if anything, has been done on the sands, which have been casually accepted if they looked good or had ever been used before in a structure that would stand up. As for the stone or gravel, all kinds and conditions of both have been used with practically no tests at all. Our work has shown that if we are to omit any of the tests we might better take a chance with the cement.

Engineering skill presupposes judgment, so why not inject it into our problems? After priming ourselves with theory, let us apply it to practice. Let us make field tests that will parallel laboratory experiments; let us conduct our laboratories in such a way that their value may be significant to the man in the field, and so that their results may be checked up by him. Success of work depends upon the field man; in every case his personality helps determine the results. Put him in line with your tests, practices, etc., and his interest and co-operation will show most profitably in the work. All of our men, from the engineer in charge of the road up, are instructed in all the tests and methods of inspection, and they complete them on every inspection of the work.

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*First Deputy Commissioner, New York Commission of Highways.

The principal tests which can be made in the field accurately enough for all practical purposes are: (1) Gradation tests for sand; (2) test for loam and silt content in sand; (3) test for set; (4) tests for stone and gravel.

An exact subgrade is necessary to save the concrete that would be wasted in evening up inequalities in the foundation. The extra time and attention spent on getting an exact subgrade will be well repaid.

The materials should be placed well in advance of the laying, so that, when the mixer has once commenced operations the work may be continuous. If the road is being constructed of imported materials, the use of a stock pile to prevent shortage will materially reduce the loss from delays in operation.

Equipment.

Attention should be given to the screed or strike board or template, as it is often called. This should be heavy enough to screed the concrete properly, and it should be cut to conform to the crown of the road. It should be provided with handles and be shod with a steel angle-iron, bent to the shape of the roadway. Wooden floats should be provided for doing the necessary floating, and the float to be used at a joint should be split in such a manner that it will ride over the joint smoothly and will cover an area of at least one foot on either side of the joint. Steel forms, while more costly than those of wood, are far more economical in the long run and pay for themselves in a short time.

Measuring barrows should be of such a type that their measurement can be regulated by the bolting of boards across the rear part of the barrows to make the quantities adjustable. Forks should be provided for taking the stone from the subgrade in order to eliminate the dirt.

The concrete road presents a good problem for the application of labor-saving devices in the handling of materials, and many different installations have shown reasonable cost reductions. The industrial railroad has played a large part in this.

Mixer in Continuous Operation

An ordinary concrete force in operation on a 16-foot road is comprised of from 32 to 35 men, doing all branches of the work; and it is quite often necessary to rearrange the gang so that the best results may be secured in keeping the mixer in continuous operation.

Suitable measuring tanks should be provided so that the amount of water may be such as to make the separate batches of the same consistency, the ideal consistency of concrete being such that it will just settle and will not run. This is very important, as the density of the resulting concrete is dependent upon it. If too wet the materials will run on the grades.

The concrete should be well spaded and kept high above the screed or strike board on the mixer side. Tamping should not be allowed. In screeding, the screed should be slowly pulled back and forth, advancing it slowly with each operation. When approaching a joint the screed should be brought up to the joint and carried back in order that the surface may be uniform. No more floating than is absolutely necessary should be resorted to, as the primary object is to have the wear on the surface taken by the stone and not by the thin mortar layer produced by floating.

Joints should always be perpendicular to the surface of the pavement. If they are not, in subsequent expansion there is often riding of the slabs. In many instances it may be necessary to stiffen up the consistency of the concrete in order that the screeding on grades will not give a ridgy effect. If possible, all work on grades of over 4 per cent. should be worked up hill.

Strength Depends on Proper Curing

Curing properly is as necessary as good construction, for upon this depends to a large extent the strength of the resulting concrete. Sprinkling should be commenced as soon as the surface will not pit, and a cover of two inches at least of sand or loam should be spread over the surface. This cover should be kept saturated with water for ten days. Care should be taken, however, not to place cover until the concrete is sufficiently firm to withstand the impact caused by placing. Sprinkling should be done in such a manner as not to wash the cover from the surface. When the temperature gets below 50 degrees F. in the middle of the day, sprinkling and cover may be omitted. When concrete is laid in cold weather its curing period should be lengthened, as low temperature retards its gain in strength. Work done in November should be allowed to cure from four to six weeks.

Earth and Gravel Road Maintenance

By R. L. Morrison*

IN our frantic efforts to develop a type of road which will carry successfully the burden of an ever-increasing daily traffic of thousands of motor vehicles, and to economically maintain these roads after they are built, we are apt to scorn, or at least to overlook, the problem of maintaining the humble earth road. The proper care of our hard surfaced roads is an immense problem, but a still greater one is the maintenance of our earth roads, which still constitute nearly 90 per cent. of our entire road mileage. Not all sections of the country have improved roads, but there is no community so small or so large, so poor or so rich that it is not confronted with the problem of getting the best possible service from the earth road.

Hardness and Smoothness to be Obtained

An earth road is a fairly good road if it is hard and smooth, and this is the object to be attained by proper maintenance. In the case of an earth road, maintenance should be taken into consideration before construction begins, for the difference between good and bad construction is mainly a matter of the resulting effect upon maintenance. A road can never be kept hard and smooth if it is so poorly located that all the surrounding land drains into it, or if the waterways are so small that they do not carry the water properly. In fact, a properly constructed earth road usually means simply a well-drained road.

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The first maintenance operation should usually consist of shaping up the road with a grader, and, under ordinary conditions, this should be done once or twice a year. Cutting should usually begin at the sides, and if the roadside is covered with sod and weeds the blade should be set on the first round in such a way that this material will be scraped into the ditches instead of onto the road. It can then be removed with shovels. Sometimes the entire road surface is covered with worn-out material mixed with dead leaves, manure, etc., and in that case this layer of worthless material should first be scraped into the ditches, or else into windrows, and then carried away in wagons. Such detritus not only makes a poor road surface, but it washes to the sides and hastens the growth of sod and weeds, which seriously interfere with proper crown drainage.

A common mistake is to make the width between ditches too great. A width of from 16 to 24 feet is usually sufficient, and unnecessary width means additional expense for maintenance. If the roadway has been made too wide in the first place, new ditches should be made nearer together.

Grader Operations

In shaping up the road with a grader some operators begin at the sides and use the entire width of the blade, if possible, the blade being set almost at right angles with the centre line of the road, so that enough material is carried along to fill up the ruts and holes. Other operators begin just outside of the wheel track and work toward the side, instead of beginning at the sides and moving a constantly increasing mass of earth. Instead of using the entire width of the blade, they raise the heel, thus allowing the earth to pass under the heel of the blade. This tends to break up clods and puddle the material. Which ever method is used, enough material is moved toward the centre at each round to build up a proper crown, but it must be remembered that a crown of one inch to the foot is sufficient. It should not be made any steeper, as a steep crown forces all traffic to follow in the same tracks, which rapidly forms ruts. Distributing the traffic over the surface helps to save the road.

The proper use of a road drag is so generally understood that it is hardly necessary to discuss it. It may be well to state, however, that wonderfully efficient as it is, the road drag is endowed with neither brains nor judgment, and if these are not possessed by the operator, good results can hardly be expected. Often the drag is used at the wrong time, or in the wrong way, or only once or twice when it should be used many times. Too many drivers seem to think that their only duty is to keep the team moving, and the almost pathetic sight of a split-log drag stirring up clouds of dust on a perfectly dry road is occasionally encountered. After it has been operated in this fashion for a while the drag is very likely to be seen at the side of the road, somewhere, with tall weeds growing around it and between the logs, while the local officials assert that they have tried dragging and found that it is not worth while.

Maintenance on Gravel Roads

The gravel road probably ranks next to the earth road in total mileage. On many trunk highways, of course, a gravel surface would be entirely unsatisfactory, but we must not overlook the fact that on roads carrying comparatively light traffic the annual interest cost of a more substantial pavement may exceed the maintenance cost of gravel.

The greatest amount of maintenance work is required during the first few months after the road has been built, before it has become thoroughly compacted and settled by traffic. The surface is likely to become badly cut up in wet weather and to ravel in dry weather. The first condition is most likely to occur if there is too much clay in the gravel, and the second if there is too little clay. During this time a road grader is usually the best tool to use, as the blade will cut off high spots, fill up hollows, and keep the crown shaped up more effectively than a drag. If the gravel contains a great excess of clay it will be necessary to add a thin layer of sand-gravel free from clay. If, on the other hand, the gravel does not contain sufficient clay to properly bind the surface, a layer of clay may be added and harrowed into the gravel. Usually from 10 to 20 per cent. of clay makes a satisfactory binder.

Scraping or dragging should be done immediately after a rain, while the road is soft enough to be worked. A scraper has some effect upon a dry road, especially where the gravel is displaced through lack of sufficient binder, but a drag should always be used when the road is wet. At first the scraping or dragging should be done after every rain, and scraping may be necessary between rains, but as the road becomes compacted by traffic ths work need not be done so often. After the first few months a drag will be as effective as a scraper, but the cutting edges of the drag should be protected by iron over their entire length.

Although the drag will keep the surface smooth and fill up small depressions, it is usually necessary to do more or less patching. The patrolman can go over his road during or just after a rain and locate the depressions by the standing water. If there is any mud in the hole it should be carefully cleaned out and the bottom should be loosened up with a pick. Unless the road is wet, the hole should be thoroughly sprinkled before it is filled. The loosening and sprinkling will insure a bond between the old and the new material.

Rolling Adds to Life

When the surfacing becomes so badly worn that patching is no longer sufficient, the road must be entirely resurfaced. This work can best be done in the spring, when the road is comparatively soft. All vegetable matter and other refuse should first be removed from the road surface, and then the old gravel should be scarified and reshaped before the layer of new material is put on. Before the new gravel is put on, the old surface should be well sprinkled to insure a good bond with the new gravel, and, if possible, it should also be rolled. The new material, similar to the top layer of a new road, is then put on, shaped, and, if possible, rolled. The surface should be kept smooth with a scraper or drag until it is well compacted.

It will add to the life of a gravel road to roll it every spring, whether extensive repairs are made or not, and it is also a good plan to roll it after the first rains in the fall. The rolling should be done when the road is fairly soft, but not while water is standing upon it.

The dragging and small repairs needed annually cost, as a rule, from $20 to $50, though sometimes $100 or more, per mile per year. Resurfacing usually has to be done at intervals of from five to ten years, at a cost equal to about two-thirds of the cost of the original gravel surface. Dividing this cost by the number of years between resurfacings, and adding the annual cost of dragging and small repairs, gives a total annual cost of from $150 to $300 per mile to keep the roads in first-class condition perpetually.

Apparently an ordinary gravel road will not carry economically more than about 150 motor cars per day without a bituminous surface treatment. Heavy asphaltic oils and tars have been used for this purpose with success, but satisfactory results are not as easily obtained as in treating macadam roads. A double treatment, first with light tar and then with a heavier tar, has proved satisfactory, even on a poor grade of gravel, and a double treatment of oil has also been successfully used.

Nothing has been said about the proper care of shoulders, side ditches, culverts, etc., but what is necessary along that line is well understood by all experienced road builders. In fact, much of the preceding discussion may seem elementary, but the maintenance of earth and gravel roads is so universally neglected that some of these elementary principles may well be brought to the attention even of highway engineers.

Developments in Brick Pavement Construction

By Fred R. Williams*

THE essential parts or elements in the construction of a brick pavement are preparing the subgrade, building the foundation, laying the bedding course, and laying the brick wearing surface.

Subgrade.

Drains should be supplied to carry away all water from the subgrade to a depth of at least two feet. They should be laid behind both curbs for the entire length of the pavement. A large percentage of the longitudinal cracks are undoubtedly caused by frost expansion due to a wet subgrade. Uniform density or firmness of the subgrade can be secured only after it has been properly drained. All spongy soil should be replaced by suitable material. In making fills, material should be deposited in layers not exceeding eight inches in thickness, and each layer should be rolled until the soil is thoroughly compacted. In excavation great care should be taken to prevent any disturbance of the soil below the subgrade.

Foundations.

In considering the type of foundation to be used the amount and kind of traffic, character of the soil, and the cost should be considered. It is often the practice to lay the brick on the natural soil if it is sandy and the street is located in a purely residential section. In sections where clay soil appears, a concrete base should be used. The top surface of the concrete base should be smooth, uniform, and parallel to the desired finished surface of the pavement. Where the cement-sand or green concrete foundation type is to be used, before placing the concrete, a prepared expansion cushion should be placed against each curb. It should have a depth equal to the combined thickness of the brick, bedding course, and concrete foundation.

Bedding Course.

In the past this has generally been the sand cushion. The use of a plain sand cushion or bedding course has undoubtedly been the cause of many failures of brick pavement, due to lack of compression or to excessive thickness. Many good pavements have been constructed using a plain sand cushion, but on account of the hazard, which neglect on the part of the contractor to give special attention to this important part of the pavement introduces, it is gradually being displaced by the cement-sand bedding course, which should not be more than one inch in thickness.

A great objection to the use of the sand cushion is that the sand will work up between the bricks, thus partially filling the space intended for grout and reducing the depth of effective bond. It used to be the practice of the contractor to make up in the cushion any excess of depth due to careless grading. Where a cement-sand bedding course is specified contractors exercise more care to obtain the proper subgrade, as they are required to make up any excess with the more expensive cement-sand mixture.

Cement Sand Bedding Course

The cement-sand bedding course, one inch in thickness, composed of one part of cement and three parts of sand, is carefully shaped to the true cross-section parallel with the finished pavement by means of a template covering one-half of the roadway, so made as to be easily drawn over the curb.

The cement and sand for the bedding course is mixed, preferably in a small batch mixer, before being spread on the concrete foundation. Less manipulation is required with the cement-sand bedding course than was formerly needed with the plain sand cushion, by reason of its greater density and uniformity at the outset, when it is thoroughly pre-mixed. It has been found that the operation of spreading and striking off the bedding course, and subsequently laying the brick thereon, proceeds more readily when the sand is slightly damp than when it is extremely dry.

Green Concrete Foundation Type.

This and the preceding pavement described are known as monolithic types. The end sought in both types is the same, namely, a firm union of base and wearing surface. In the cement-sand bedding course type this union is secured by a cementitious bedding course; in the green concrete foundation type by laying the brick on the green concrete foundation. In the latter there is no bedding course employed other than a thin film of dry mortar, spread by special template at the same time the concrete is cut to its proper contour and elevation.

Uniformity in mixing the concrete is an important factor in securing the best results with the green concrete foundation type. A quaking mix has been found most satisfactory, since this assures enough water for hydrating the cement, making it easy of handling and at the same time providing a stable support for the brick surface during laying and rolling. In no event should so much water be used that the excess flows to the side of the street, washing with it cement and sand out of the coarse aggregate.

Cement Grout Filler.

The operation of applying the cement grout filler in any type is one requiring care throughout if the full advantages inherent to this type of filler are to be realized. The best results are secured with a thorough pre-mixing of the cement and sand in the proportions of one part cement to one part sand. A small amount, approximately two cubic feet, is then placed in the box and water gradually added; in the meantime the whole is thoroughly mixed.

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*Engineer of Paving, Cleveland, Ohio

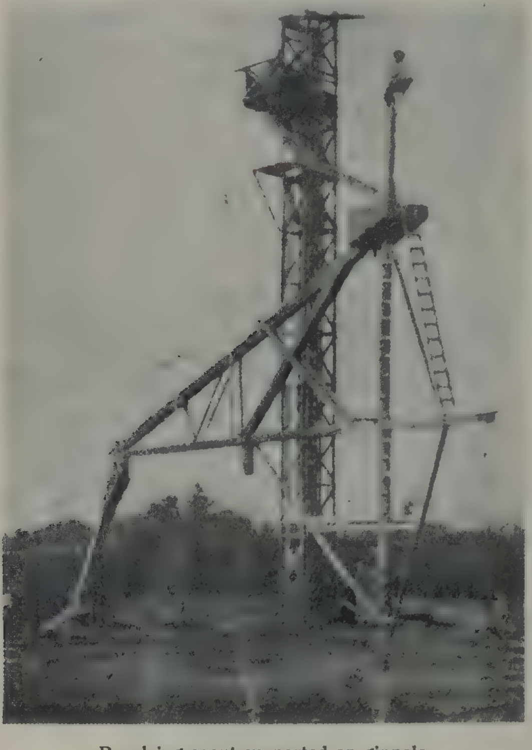
Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Concreting with Chute on Revolving Mast

In concreting two circular concrete settling basins for a central concrete plant was used for both basins, from which concrete was distributed to the walls through a revolving chute supported from a ginpole, set in turn at the centre of each basin. The installation, which proved very successful, is plainly shown in the photograph, and is described by C. F. Lambert in Engineering Record.

Each of these basins has an inside diameter of 105 ft., with thin walls 10 ft. high. The walls, which are entirely above ground, are 6 in. thick at the top and 8 in. at the bottom. The basins are floored with 6 in. of concrete, sloped toward the centre for drainage. At this point a 6-in. cast elbow connecting with the drain pipe is set. This elbow was placed first in each basin and used as a step for the ginpole. The pole was fastened by a guy spider and pin at the top, which left it free to revolve. Concrete was spouted from the central tower to a wood hopper built around the pole at the proper height, from which a second wood chute, supported from the pole as a boom, distributed it to the walls. An opening in the chute about halfway down, from which a vertical spout could be hung, permitted concreting the floor without a return spout. When the first basin was completed, the pole and chutes were moved over to the second basin.


Revolving spout supported on ginpole.

The obvious economy of this method of distributing the concrete could be taken advantage of in this sort of construction, where thin walls above ground had to be made absolutely watertight, because of the use of hydrated lime in the concrete. This was mixed with one part cement to six parts aggregate, the aggregate being a mixture of sand and gravel, which gave the proportion of an ordinary 1:2:4 mix. The hydrated lime used was about 10 or 12 per cent. by volume of the cement. The 450 yards of concrete which was mixed with hydrated lime flowed very freely through the chutes, did not require an undue amount of water, and did not separate, and produced a smooth surface against the forms. The resulting construction was absolutely watertight.

A Bucket Hoist Using Water Power

A simple "hydraulic hoist" for raising materials from the ground to the top of a building is described by A. P. Rounds in a recent issue of Concrete. The apparatus, which is cheap and easily improvised, can find application and be profitably employed on small jobs where the initial cost of installing an elevator is prohibitive. It consisted of a light wooden frame erected on the roof and overhanging the edge. To the frame two well-wheels were attached, 10 feet above the roof. Over these wheels ran a rope and to each end of the rope was attached a wooden bucket. The rope was of such a length that when one bucket was on the ground the other would be about 3 feet above the roof. Each bucket had a capacity of 2½ cubic feet, and one was used for materials and the other for water. The material bucket was slightly heavier than the water bucket, so that when the hoist was at rest the material bucket would be on the ground. The well-wheels were placed 12 in. apart, so that there would be no interference between the buckets as they passed up and down.

The water bucket was filled from a 50-gallon barrel. into this barrel water flowed continuously through a ¾-in. pipe at 50 pounds pressure. The barrel was placed in a horizontal position, near the edge and above three above the roof, with its long axis parallel with the edge of the roof. A shaft was passed through the heads, slightly off centre, and a frame was erected to carry the shaft and allow it to revolve freely. In one side of the barrel, near the top, a circular opening was cut and a sheet metal spout attached in such a position that when the barrel was slightly revolved the spout would discharge water into the water bucket. An arm was attached to the head of the barrel at right angles to the horizontal axis, and a man was stationed beside the barrel to fill the water bucket at the proper time. The hoisting operation consisted in filling the bucket on the ground with the material to be raised, then revolving the water barrel, allowing the water to flow into the water bucket. The water bucket would then descend and the material bucket rise. When the material arrived at the right height it would be stopped by the water bucket reaching the ground, and the material would be dumped into wheelbarrows and the water into the sewer.

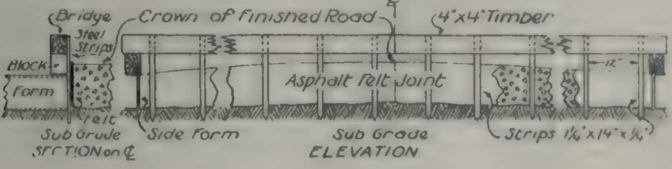
This hoist was used for raising slag for roofing. The distance from ground to roof was 28 ft. Two men were required to operate the hoist, and the average load carried each trip was 2½ cubic feet. The maximum speed attained was two trips per min. An average speed of 65 trips per hour was maintained. The men tending hoist received 25 cents and 28 cents per hour. From this it is seen that the labor cost of raising the slag was 12 cents per ton (calling the weight of slag 55 pounds per cubic foot). The frame to which the well-wheels were attached was erected at a cost of $1.80, and 210 feet b.m. of lumber was required for this purpose. Besides this, there was a slight expense for water, and the initial cost of $2.10 for making and installing the hardware on buckets and water barrel.

On this work the material was shoveled from the car into wheelbarrows, dumped from wheelbarrow into buckets, then dumped from bucket into wheelbarrow again, and wheeled to place near where it was to be used.

Device for Installing Expansion Joints

There are several reasons, among them appearance being no small item, why expansion joints in a concrete road should be straight across the road in a vertical plane. Most engineers like to see them placed in this manner principally because it is the way they should be placed. It is often found to be a difficult task to install a strip expansion joint without waves and bulges unless some special means is resorted to in holding the strip in position until the concrete has been placed on both sides and tamped firmly against the joint strip. The illustration, from Cement World, shows a cheap and easily-constructed device which not only assures straight joints, but also furnishes a means of installing the joints in a very short time.

The metal fingers are held against the side of the 4 in. x 4 in. bridge timber by means of two screws in each strip. The fingers are made of such a length that when the bridge is set upon blocks nailed to each end and these blocks are rested on the forms the pointed ends will project into the subgrade about 1½ inches. The centre of the bridge should clear the crown of the finished road by at least two inches. The fingers should be spaced close enough to one another to prevent bulging between, usually about 12 inches on centres.



Device produces straight expansion joints.

The joint strip is placed on the outer face of the fingers and the concrete is filled in on this side until the strip is held firmly in place. After the next slab has been started and the expansion strip is entirely embedded the device may be easily removed and used on the next joint.

Mr. John F. Greene has resigned as Bridge Engineer for the city of Calgary, and has accepted an engagement with the Carter-Halls-Aldinger Company of Winnipeg. Mr. Greene was the designing engineer on the reinforced concrete arch bridge over the Bow River in Calgary, which has just been completed. A paper describing this bridge was printed in our issue of February 14.

Personal

Lieut. Lewis W. Wynne-Roberts, R.E., is a son of Mr. R. O. Wynne-Roberts, consulting engineer, Toronto, and was formerly an assistant engineer in the Highways Department of the Saskatchewan Government in Regina, principally in connection with the Saskatoon reinforced concrete bridge. Lieut. Wynne-Roberts resigned his appointment in November, 1915, and, proceeding to England, offered his services to the War Office and was accepted. Pending an opening at Chatham, he was asked to tender services in connection with munitions. He joined the staff of the Liverpool Corporation Engineering Works, and shortly afterwards had charge of about 90 women mechanics. On receipt of orders he reported at the Chatham Training School for Royal Engineers, and in due time passed the examinations creditably. He was recently selected for duty in Mesopotamia, and sailed for that battle-front on Feb. 10. Lieut. Wynne-Roberts was educated at the South African College, Cape Town, where he gained the Victoria Scholarship; at Towyn County School, Wales, and at the Battersea Technical College, London, where he gained a scholarship and was gold medalist in his final year. He is a B.Sc. Honors (Engineering), London University, and a Junior member of the Canadian Society of Civil Engineers.

Lieut. Lewis W. Wynne-Roberts.

Mainly Constructional

East and West—From Coast to Coast

A permit has been issued for the erection of a new theatre by Loew's Montreal Theatres, Limited, to cost $175,000. The new building will be 174 x 174 feet in dimensions and will be located on Mansfield Street.

The ratepayers of Orillia, Ont., recently carried a by-law to raise by debenture $18,000 for the completion of the new municipal building. The original by-law, passed a year ago, was for $35,000. It is expected the new building will be opened early in March.

The old Agricultural College building in Winnipeg has been turned over by the Provincial Government to the Military Commission, to be used for hospital and convalescent home purposes. A start will be made immediately to recon struct the buildings in order that a convalescent home of 600 beds may be available by April 15.

A new theatre, to be known as the "Imperial," will be erected on the site of the present Palace Royal on St. Joseph Street, Quebec. The new building will be of fireproof construction and modern in all its appointments, and will have a much larger capacity than the old house.

Estimates on various plans covering the proposed joint water system for the five border municipalities, Windsor, Walkerville, Ford, Sandwich and Ojibway, were recently submitted to the Essex Border Utilities Commission. The lowest figure was $450,000, while the largest amounted to $1,302,000.

A new motion picture theatre is to be erected in Fredericton, N.B., on Queen Street. This building will be of steel and concrete construction, thoroughly fireproof throughout, and will accommodate 1,000 people. Active work will probably be commenced by the first of May and the new theatre opened to the public by the first week in September.

A new store and office building is nearing completion in Charlottetown, P.E.I., for Messrs. T. B. and D. J. Riley. The building has a frontage of 43 feet on Queen Street and a depth of 75 feet with a rear entrance from Richmond Street, and is three storeys and basement in height. The whole building is of brick, with concrete trimmings. It was designed by Messrs. C. B. Chappell and Hunter and was erected by day labor.

Rough estimates, made by the board of directors of the Kootenay Lake, B. C., general hospital recently, showed $85,000 as the approximate outside total cost of the building, based on the architect's estimates and the figures contained in the tenders submitted by several firms of contractors. Already $15,000 has been spent on the erection of the building and an additional outlay of $52,000 will be required on the construction work, as shown by the tenders.

The council of York Township, Ont., have awarded contracts for the material required in connection with their proposed waterworks system. These contracts, covering the initial stages of the scheme, amount to over $200,000. They were given, in every case, to local firms. Some of the larger items were: the National Iron Works, 24-inch iron pipes, $97,000; the Canadian Allis-Chalmers Co., 12-inch cast iron pipes, $83,000; the National Iron Works, special castings, $12,000.

The Marine and Fisheries Department at Ottawa has awarded the contract for the construction of the lighthouse, which is to be erected on the outer end of the Ogden Point breakwater, Victoria, B.C., to Messrs. Parfitt Brothers, contractors, of Victoria, the figure being in the neighborhood of $20,000. The structure, which will be of concrete, will rise 25 feet above the surface of the present headblock, which is on a level with the top of the parapet, and the dome will contain a powerful beacon of the Aga system.

Messrs. P. H. Secord & Sons, Limited, general contractors, of Brantford, Ont., advise that they are open for tenders on the following sub-contracts in connection with the erection of the proposed new Loew's Theatre at Hamilton. Plans may be seen at their office: Terra cotta; structural steel work; reinforcing materials; ornamental iron and bronze work; sheet metal work and roofing; plastering, furring and metal lath; hardware; fireproof materials, kalamein doors and windows; glass; tile, terrazzo, marble and slate; brass work; painting.

The ratepayers of Chatham, Ont., have carried a by-law granting a site of 11 acres, valued at $5,500, to Libby, McNeil & Libby Company of Canada, for the establishment of a large packing and pickling plant. The company is also granted a fixed assessment of $5,500 for a period of ten years, with the usual exemptions of local improvement and school taxes. The firm, which is a branch of the Chicago packing house of the same name, will make an initial expenditure of more than $100,000 on a plant to care for business in Canada and the British possessions.

Among the engineers and others who represented Canada at the convention of the American Road Builders' Association, held recently at Boston, Mass., were the following: J. Duchastel, president of the Dominion Good Roads Association, of Montreal; Paul E. Mercier, Montreal; George Hogarth, Toronto; H. A. Brazier, London; George McNamee, Montreal; E. R. Gray, Hamilton; E. S. Fraser, New Glasgow, N.S.; H. M. Hatfield, Halifax, N.S.; V. C. Lessard, Levis, Que.; J. DeBoise, Quebec, Que.; G. N. Harfield, St. John, N.B.; J. W. Tyrrell, Hamilton; W. E. McKenzie, Moncton, N.B.; B. A. Janin, Montreal; F. X. Galibois, Quebec.

At a recent meeting the property committee of the Toronto Board of Education passed the following items in the estimates for school buildings: $90,000 for the erection of a new school for the relief of Winchester and Rose Avenue schools, to contain at least 15 class rooms; $80,000, District of Keele and Western Avenue schools, 11 rooms; $75,000, Fern Avenue, Parkdale, and Howard Street schools, 12 rooms; $75,000, Ryerson and Ogden Schools, 12 rooms; $50,000, District of Norway School, 8 rooms; $50,000, six-roomed addition to Dewson Street School; $15,000, new Supply Department storehouse; $12,000 for the completion of the assembly room for North Toronto High School.

A deputation representing the different municipalities along the Lake Shore Road between Toronto and Hamilton recently interviewed the Toronto-Hamilton Highway Commission Board to ascertain if the proposed legislation to appoint an inter-provincial highway commission would serve their interests better than the present organization. It was the opinion of the Toronto-Hamilton Commission that as far as the construction work was concerned the cost to the municipalities would be the same. On the proposed inter-provincial highways leading from city to city throughout Ontario, the government would pay 70 per cent. and the municipalities 30 per cent. Under the present arrangement regarding the Toronto-Hamilton highway, the government pays 40 per cent., the municipalities 30 per cent., and the cities of Toronto and Hamilton 30 per cent., as the road is being laid in a strictly suburban area. As regards the maintenance, however, it is understood that no arrangement has been made by the government.

At the recent annual convention of the Ontario Provincial Builders and Supply Association, held at London, Ont., the following officers were elected:—Honorary president, T. R. Wright, London; president, C. T. Pearce, Hamilton; first vice-president, A. Tomlinson, Chatham; second vice-president, Lieut.-Col. J. A. Young, V. C., Stratford; secretary, S. Coombs, Hamilton; treasurer, Geo. Oakley, Jr., Toronto; executive committee, J. S. Webster, Galt, G. A. Crain, Ottawa, W. Murray, Hamilton, J. Norton, Sarnia, G. Gander, Toronto, E. Blonde, Chatham, G. Pounder, Stratford, C. Chapman, St. Catharines, L. H. Martyn, London. The members of the association, at their meeting, discussed measures to combat foreign and alien competition in the building trades in Ontario. It was claimed that the contractors are feeling outside competition in a serious degree on all of the larger enterprises. Committees were also appointed to interview the Workmen's Compensation Board to adjust matters associated with the provision of first aid and medical attendences to injured workmen.

The opening of the big interstate bridge across the Columbia River at Vancouver, Wash., was celebrated on Feb. 14. This bridge has been three years in building, and has cost $1,750,000. It is one of the longest bridges of its kind in the world.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 March 7, 1917 No. 10

Principal Contents

Page
Editorial 193
Contractors' Organization on Big Aqueduct 194
Delegates at Ontario Good Roads Convention Discuss Highway Problems and Conditions 196
Highways of the Eastern States 199
Benefits of County Roads 201
Comparison of Activated Sludge and Imhoff Tank-Trickling Filter Processes 203
Tests for Organic Impurities in Sand 206
Joint Fillers for Granite Blocks 207
Clay Products in Engineering Construction 209
Changes in Wood Block Paving Practice 210
Practical Hints for Contractors 211
Mainly Constructional 212

Graded Aggregates from a Central Plant

ONE of the distinctive features of the work in connection with the construction of the Greater Winnipeg aqueduct was the supplying to the contractors by the District authorities of graded aggregate prepared at a centralized mixing plant. A detailed account of these efforts formed the basis of an article appearing in the last issue of the Contract Record. Furnishing a concrete aggregate, carefully graded and properly proportioned, at a central plant, to contractors operating over a widespread area, is more or less a new departure, but, as indicated in the article referred to, the results have been so successful and economical as to make a more universal adoption of the scheme highly commendable.

The evolution of an arrangement for the supply of graded aggregate was extremely desirable, and, in a sense, obligatory in a project as extensive as the Winnipeg aqueduct, where the length of the work introduced peculiar difficulties of transportation and delivery, more especially, as construction was being carried on in all portions of the work at the same time. A uniformly watertight and economical concrete throughout the structure was essential, which, with the multiplication of contracts and widely separated working points, would have proved difficult to obtain, had contractors been required to prepare their own stone and sand, without the means of securing uniformity at all points. The lack of sufficient pits at the various sites of work imposed high haulage costs, and it was therefore highly desirable that as much of the labor of grading, mixing and inspecting as possible be done at a central point to avoid any appreciable degree of local re-handling.

Self-evident advantages are attached to the supply of graded aggregate from a central mixing plant. The District's forces have, with two years' experience, been able to give the method a thorough test, and by a direct comparison with the separate delivery of materials, have been able to observe its merits. The mixing, being performed in pre-determined amounts and in accordance with requirements, produces an aggregate designed to result in a dense, impermeable, concrete, uniform at all working points. Skilled inspectors at the pit ensure proper proportioning and abolish the need of any local inspections. The mixed aggregate is, moreover, easier and cheaper for the contractor to handle than separated materials. It has been determined, also, that by using mixed aggregates with cement in the proportion of 1:6, which may be compared with a standard 1:2:4 mix, a saving of nearly $1 per cubic yard is obtained.

The experience gained by the adoption of this method on the Winnipeg aqueduct presages much for the successful application on all kinds of work. It is for large projects, of course, that the merits will be especially evident, and yet, by having smaller jobs served in the manner outlined, from a central organization, there are brighter prospects for better and improved concrete.

Ontario Government Promises Aggressive Road Program

IT was expected that, at the meeting of the Ontario Good Roads Association held last week in Toronto, reported in this issue, the highway policy of the Ontario Government would be explained. It is the government's intention, as indicated in the speech from the Throne at the recent opening of the Legislature, to put before the house a program for the building of a system of provincial highways. It will be remembered that the provincial highway commissioners outlined in 1913 a scheme of road improvement involving the expenditure of $30,000,000. The outbreak of war upset the plans before any material progress was made, and in the last two years the economies practised universally by our municipalities have forbidden any considerable appropriations for road purposes. The work is so important, however, that its progress should not be delayed any more than is necessary, and the Minister of Public Works has intimated that the government is getting ready to make a start on an extensive scale.

Although the plans of the government were not completely outlined at the meeting of the Ontario

Good Roads Association, Hon. Mr. F. G. Macdiarmid, Minister of Public Works, gave a few hints as to the government's intentions. The automobile was the cause of changed conditions in this province, and after a careful survey of the situation, the government realized that the time has arrived when it should step in and take care of this traffic, which has enormously increased, and is not local in any sense. The government aims to establish a system of provincial highways, which will connect up with the existing county road systems throughout the province. As these roads will be developed as a direct result of the motor traffic, it is the government's aim to bear a very large proportion of the expenditure, apportioning to the municipalities only a fair share. The chief development will be a cross-provincial thoroughfare from Windsor to Montreal, which will directly serve sixty per cent. of the population of the province.

It is perhaps regrettable that the government does not see its way clear to guarantee any immediate efforts on a large scale, but it is hardly likely that any aggressive action will be taken to do much construction work until after the war. In the meantime, however, the Good Roads Department will busy itself getting its organization into such shape that when the proper time comes, the scheme can be entered upon promptly and in a businesslike way. In this way this progressive road program is being made a part of an energetic attempt to cope with the problems which will follow the war.

Contractors' Organization on Big Aqueduct

Second Article on Greater Winnipeg Water Supply Describes Administrative, Construction, and Camp Arrangements—Telephone an Aid to Progress

By G. F. Richan[*]

THIS article is the second of a series of six articles which describe the contractors' work on the construction of the 85-mile concrete aqueduct section of the Greater Winnipeg water supply. For a general description of the undertaking see page 175 of this magazine. The purpose of this article is to describe the contractors' organization on the five contracts—Nos. 30, 31, 32, 33, and 34—which cover the work of building the 85 miles of concrete aqueduct.

Required Progress Governs Organization

The construction organization for this work, while dependent on the initiative and resourcefulness of the individual contracting firms, was affected largely by the following factors: The progress required (four seasons of some 150 days each was the time available for the work), the nature of the portion of the country included in the contract and the machinery and forms which could be economically purchased for the work. Each one of the five contracts was of such length as to require three working points in order to make the necessary progress. This number of working points had the effect of dividing the contractors' organization into, first, the staff or force whose work had to do with all the working points; and, second, the force required at each working point. For maximum progress the contractor's forces at each working point had to be so organized that the operations of excavating the trench, of trimming for the inverts, of pouring inverts, of pouring arches, and of backfilling could proceed without any one of the operations holding up the others.

Contracts Nos. 32, 33, and 34, including all the work between 50.3 and the intake site at Mile 97.6 were awarded to the Carter-Halls-Aldinger Company, Ltd., and the Northern Construction Company, Ltd., of Winnipeg, as joint tenderers. These two well-known local construction firms combined to form an organization, which was incorporated under the name of the Winnipeg Aqueduct Construction Company, with Mr. A. C. MacKenzie as president and Messrs. A. H. Aldinger and F. E. Halls as vice-president and secretary-treasurer respectively, Mr. J. B. McLean, manager, and Mr. William Smaill, general superintendent. The head office of the firm is in the Union Bank Building, Winnipeg, and a field office, the headquarters of the general superintendent, is located at Mile 64, at the District Railway Siding No. 6, near the crossing of the Whitemouth River.

Staff, Shop, and Camp Arrangement

The head office staff consists of an assistant secretary-treasurer, an accountant, an assistant accountant, a purchasing agent, two stenographers, and a clerk. The staff at the field office consists of a material clerk, timekeeper, engineer, and assistant, and during the working season, when the camps are in operation, a travelling steward is in charge of the commissariat. There is also located at the field headquarters a repair shop force, including a blacksmith and helper, one or more carpenters, and a gasoline motor expert.

The repair shops, which are required by the terms of the contract, include carpenter and machine shops, blacksmith shop, and a shop fitted for the repair of the gasoline engines used with trench pumps, and track motor cars, and a small building erected for the use of an oxy-acetylene welding equipment.

Power is supplied to the carpenter and machine shops by a two-cylinder 18 h.p. gasoline motor, and the shops are equipped with the wood and metal working machinery necessary for all ordinary repairs to the plant used on the work. A supply of spare parts is kept in stock to further minimize the time lost on account of breakdowns.

Active construction was started in the spring of 1915 at seven separate points, including the Whitemouth River Crossing, for which a camp was maintained at field headquarters until the completion of the crossing work at the end of that season, when it was discontinued. At each opening camp buildings had been erected, with a capacity of 100 men. (See Fig. No. 1.) In the following winter two more camps were added, and another is now being erected, so that a total of nine camps will be in operation during the season of 1917.

Hundred Men at Each Working Point

To make the maximum progress at each working point with the forms and other equipment provided there is required a force of at least one hundred men, classified generally as follows:

Superintendent	1
Foreman	1

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[*] Division Engineer, Greater Winnipeg Water District.

Timekeeper	1
Form carpenters	2
Steel form handlers (two gangs, including a foreman and laborers)	20
Cement finishers	4
Engineer (concrete mixer)	1
Engineer (dinky)	1
Drag line excavator, two crews	4
Pumpmen	4
Common laborers, trimming trench, drainage work, etc.	60

Owing to the general shortage of labor in 1916 and to the fact that under the terms of the contract residents of the District only may be employed when such are available, the force has been variable, and usually below the number desired. However, under favorable conditions at some camps, a rate of progress considerably better than the scheduled average has been maintained, with a force of from 60 to 70 men.

Each camp is connected with the field and head office by telephone, and daily progress reports are thus made to field headquarters, where they are tabulated and recorded and a daily report is telephoned to the manager at the head office in Winnipeg.

Reports Transmitted By Telephone

The telephone system was installed by the company for their own use, placing wires, by rental agreement, on the poles of the District's system. A connection was made with the District gravel pit at Mile 31, and each night during the working season the requirements for sand, gravel, or aggregate material for the following day's delivery are sent to the pit foreman. Through a switchboard at Deacon, Mile 13 (the headquarters of the district railway), a connection is made with the District's telephone system, putting the field offices in connection with the District train despatcher whenever information is required concerning the movements of gravel trains, cement deliveries, or the placing of material cars.

Fig. 1—Camp buildings with a capacity of 100 men are erected at all working points.

The contracting company is bound by the contract to furnish board and shelter to the men at $5 per week, and it is the duty of the travelling steward to supervise the work of the camp cooks, order commissary supplies, and to see that sufficient wholesome, well-cooked food is supplied, all at a reasonable profit to the company. The foremen are thus relieved of all responsibility for the conduct of this department, and their time and energy conserved for their proper duties.

A field hospital at Mile 77 is connected with the company's telephone system, and the medical attendant is provided with a track motor car for use in answering special calls or for attending patients at the various camps when the regular train service is not available. Owing to a strict supervision of the sanitary arrangements at all camps, by the officials of the contracting company as well as by those of the Water District, the work of the medical officer is usually confined to first aid work for minor accidents.

Contract 31, extending from Mile 33 to Mile 50.3, was awarded to Thomas Kelly & Sons, of Winnipeg. During 1915 and 1916 they had working on the contract three camps of a rated capacity of 100 men each, under a field superintendent. The prosecution of the work was managed from the Winnipeg office, but due to absence of a telephone system, lack of repair shops, together with machinery not too well adapted to the work on hand, they were unable to keep their progress up to the contract schedule. In order to overtake the required progress so as to complete their work, in the fall of 1918 these contractors are purchasing additional equipment, putting in two new camps, installing a telephone line, making each of their camps capable of accommodating 150 men, and have appointed J. A. Astley, C.E., formerly engineer of construction for the City of Winnipeg, as their general superintendent. Their field organization will thus be similar to that of the Winnipeg Aqueduct Company. With the efforts being put forward they should be able to carry the work forward to successful conclusion.

Work Up to Schedule.

Contract 30, extending from Mile 13 to Mile 33, was awarded to the J. H. Tremblay Company, of Winnipeg. With this company is associated in this contract the J. J. McDiarmid Company, also of Winnipeg. The head office work of this company is carried along by the company's staff in Winnipeg, which handles work arising from other contracts in the city. The field organization is under Mr. Albert Tremblay, general superintendent. In 1915 they had two camps, and in 1916 three camps, each with accommodation for 100 men, and were able to keep the work up to the progress required by the contract schedule. A typical distribution of the labor at one camp for 1916 would be:

Superintendent	1
Foremen	3
Bookkeeper	1
Blacksmith	1
Carpenter	1
Form handlers	7
Form laborers	7
Cement finishers	2
Stationary engineers (mixer)	2
Laborers	42
Teamsters	3
Total	70 men

The open prairie country through which most of this contract is located had much to do with the speed of work and with enabling a small force to accomplish as much as could be done by a larger force in more difficult country but credit must also be given to the energy and resourcefulness displayed by the men of this organization, which was without a doubt an important factor in the successful manner in which this work has been carried forward to date.

Ten years ago, one-fourth of the annual production of cement went into building construction, whereas to-day one-half of the cement produced serves the same purpose.

Delegates at Ontario Good Roads Convention Discuss Highway Problems and Conditions

THE fifteenth annual convention of the Ontario Good Roads Association was held in Toronto on the three days, February 27 to March 1, inclusive. Delegates from all parts of the province met in the York County Buildings, and the unfailing interest in the work of the association was evidenced by the unusually large attendance. The members were greeted by Mayor Church on behalf of the City of Toronto, who extended to them a very hearty welcome. He emphasized the importance of their work, and said he regretted that the government in the past had not given the good roads movement the attention it deserved. The cause of under-production in Ontario was the lack of a proper system of main roads and trunk roads throughout the province. He mentioned the new highway policy which the Ontario Government was introducing, and expressed the hope that the government would have the courage to go forward and not permit the financial situation or other considerations to hold back this important work. Toronto was a pioneer in good roads' work, and was always ready to help the movement along. The city's interest in highway improvement was shown by their action in regard to the Toronto-Hamilton highway, to which they were contributing over $400,000. Congratulating the association on the success of their work in the past, he said that they had been leaders and educators of public opinion, and he wished them every success in their work in the future.

The President's Address.

In his presidential address, Mr. S. L. Squire, of Waterford, urged the great importance of such associations as the Ontario Good Roads Association and dwelt on the necessity for good roads throughout the province. Wherever centres of population feel the pinch of under-production there was the immediate demand for better roadways. The building of steam and electric roads did not lessen the need for improved highways, but their success was dependent on this very factor. With the increasing use of the motor truck there came always the demand for good roads, and by means of the truck the products of the farm could be transported to the centres of population rapidly and delivered in their best condition. Dealing with the question of the responsibility for the improvement of streets and roadways, he said that this work belonged to the municipalities or communities through which they pass, and that it was not the part of the government to snatch from them what through time and experience had become their right. The duty of the government was to assist and encourage. It should do all the experimenting and suggest ways and means for all conditions. The Department of Highways should form a department for research and investigation and pass the results on to the municipalities. The employment of returned soldiers was a matter which the president said was closely related to the good roads movement. Large numbers of soldiers, on their return from the front, would be available for just such work as highway improvement projects could supply. The responsibility did not rest with the government alone, but the municipalities must also do their share. There was, besides, a large number of munition workers and others who would be thrown out of work at the end of the war, and for whom work would have to be provided. He believed that there would undoubtedly be some 40,000 men available in the province for highway construction, and it was the duty of the municipal, provincial, and federal authorities to arrange a system of roads which would take care of this unemployment. In conclusion, he said that the government must place before the municipalities the highest ideals and best methods in road building, so that a system of roads might be built up which would be a credit to the province.

Hon. Mr. Macdiarmid.

Hon. F. G. Macdiarmid, Minister of Public Works and Highways of the Province of Ontario, in opening his address to the members of the association, expressed his pleasure at meeting such a large gathering and seeing such interest taken in the question of good roads. He complimented the City of Toronto on the spirit of co-operation it had shown in the good roads movement in the County of York and the surrounding district. With the connecting up of the system and the completion of the Toronto-Hamilton highway he said the full benefit of the improvements would be realized. The construction of good roads had a direct bearing on the cost of living. The use of the motor truck as a commercial vehicle was coming more and more in evidence, and by this means of transportation a reduction would be effected in the number of times produce had to be handled, and it would be placed in the hands of the consumer in better condition. During the past two years conditions had not been favorable to road construction on account of the scarcity of labor, which was in such demand in other fields. In the past year four more counties had come into the good roads system, making a total of 24 counties out of 37. The Minister referred to the legislation which had been introduced last year to increase the government grant on road construction from 33 to 40 per cent., and also to provide 20 per cent. of the maintenance. Legislation had been passed to encourage the employment of county road superintendents, because the government believed that this ensured greater continuity in construction work and relieved the members of the council of a considerable burden. The appointment of a commissioner was, in the Minister's opinion, an excellent basis on which to organize road work.

System of Provincial Highways.

With the coming of the motor truck conditions of traffic had changed, and motor traffic was very rapidly growing. Last year the revenue from motor licenses was $650,000, and if the average ratio of increase continued this year it would reach $750,000. To take care of this new and rapidly increasing class of traffic, which was not merely local, but provincial and international, the government felt the time had arrived when the province should step in and construct a system of provincial highways in Ontario. This development was a direct result of the motor traffic, and the government would not place on the shoulders of the municipalities more than their fair share of the cost, it being the intention of the province to assume a very substantial proportion of the necessary expenditure. The new system would connect up the county roads systems throughout Ontario, and the Minister stated that it was proposed to build a road from Windsor to Montreal. Within a distance of 12 miles on either side of the proposed highway a very large proportion of the population of the province was concentrated, and so the new road would be of the greatest benefit to the greatest number. The Minister did not wish, however, to raise the hope that there would be any big effort at construction work until after the war, but in the meantime the organization would be got into shape. Repair work should, however, always be carried on, and he believed there was sufficient labor to do so. The Minister also stated that his department would be governed largely by the opinions of the association expressed during their convention.

With regard to a tendency he had noticed to agitate for the return of automobile fees to the separate municipalities, Mr. Macdiarmid said he thought such a policy would jeopardize the whole good roads movement in the province if it were endorsed and supported by any large body of public opinion.

Rural and Urban Intercommunication.

Controller Thomas Foster, of Toronto, addressed the association on the subject of rural and urban intercommunication. He spoke first, however, of his late experience on the Continent and in England, and of the admirable roads he had seen, built on the foundations laid by the Romans, and still in first-class condition. Coming back to the United States, he mentioned the state road running between New York and Buffalo. The section between New York and Syracuse, he said, had been built of tar macadam. Its construction, however, created a tremendous traffic, and, as a result, the road was not a success. Further north, on the same road, it was decided to build a brick pavement on a concrete foundation, and this construction proved satisfactory. In the cities of Western Canada he had noticed that concrete and asphalt roads were principally constructed. He said that in Toronto experiments had been made with every class of pavement to find a durable and economical construction, and told how the old granite block pavements, which were slippery, noisy, and rough, had been replaced by concrete roads with a heavy asphalt covering. It was very easy to repair asphalt when there was a good foundation, and this class of construction seemed to be most satisfactory. He then told something of what the Toronto and York Highways Commission had been doing. He said that when he was appointed to the commission he had suggested some improvements which appeared necessary. Instead of limestone surfaces on macadam roads he proposed that something more permanent be used, such as granite or trap rock. He considered that the cross-lines and side-lines which the Commission had been putting down, 12 feet wide, were too narrow, and suggested that the cross-lines be made 18 feet wide and the main arteries at least 18 feet or 20 feet. Later bituminous-bound madacam had been adopted and better surfaces obtained. The Commission had been organized in July, 1911, for the purpose of improvement work on the roads leading into the city from the county. It had then 110 miles under its jurisdiction, but the area was extended in 1915 to cover the whole of York County. Construction work in 1911 had been light, water-bound macadam being laid, at a cost of about $6,000 per mile. In 1912 a heavier type was built, at a cost of about $7,000 per mile, while in 1913 bituminous-bound macadam roads had been constructed, at a cost of $10,000 per mile. An 18-foot brick pavement had been laid on Dundas Street in 1916, at a cost of $24,000 per mile. This road was of reinforced construction, the very best materials being used, and he believed it to be one of the finest pieces of road in Canada. The controller went on to tell how two million dollars had been spent to provide good lines of communication between the city and the rural districts, and he said that adequate return had not been received from this expenditure; the farmers did not take full advantage of the good roads. It had been expected that the present market in Toronto would have had to be enlarged to accommodate a big increase in the amount of produce brought into the city by the farmers, but this had not been realized, and the market was still larger than was necessary to meet the requirements of the present time. His conclusion was that the cost of labor for bringing the produce to the market was, perhaps, too high, and he suggested that the farmers use a co-operative scheme, such as was employed in the Old Country. The produce could be collected systematically from the various farms in a district and conveyed to the city by one man, thus greatly reducing the cost of transportation and eliminating the middleman's profit, with mutual benefit to producer and consumer. He said that the district between Toronto and Hamilton should be one of the greatest producing sections on the continent, and it was his idea that the land should be divided into five, ten, and twenty-acre farms and intensively cultivated.

Speaking of the question of ornamental work along the roads, the controller expressed the opinion that the Toronto and York Highways Commission should be granted power to expend a small amount in improving the appearance of the highways.

Road Traffic and Regulation.

In a short address Warden J. G. Cornell, of York County, dealt with the question of "Road Traffic and Its Regulation." He said that the York County Council had abolished the fee system, and that, as a result, there was better feeling between the constables and the motorists, as the latter knew that the constables had no selfish interest in holding up the automobile owners for exceeding the speed limit. The warden made reference to the address by Controller Foster, and stated that one of the reasons why there was not a greater amount of produce brought into the market over the improved roads was that a large amount of the territory around Toronto had been subdivided and was not used for farming purposes; also there were a great many farms surrounding the city given over to dairy work. He said, however, that market gardeners and small farmers were going out further from the city since the good roads had been built than they otherwise would have. As a representative of York County, he was in hearty accord with the good roads movement. Their experience was that the district was improved thereby and the lands increased in value, while the taxes were not a burden.

The Roads Behind the Trenches

Major T. L. Kennedy, of Dixie, a past president of the Ontario Good Roads Association, delivered an interesting address on the roads behind the trenches on the western front. Referring to the attitude toward road-building in France and Belgium, and also in England, he said that he found a different spirit existing to that shown in Canada. Every highway was considered a state highway, and a centralized board could build roads without arousing jealousy as to the location. There was a very high tax in France for road work, 60 per cent., which, however, was considered necessary and paid without grumbling. Mentioning the road between Calais and Paris, over part of which he had travelled, he said it was the finest road he had ever seen. It was 27 feet wide, built of granite paving block, laid on solid macadam over the old road built by the Romans. Every mile was patrolled each day, so that it was always safe for transport. It was no unusual thing to see 30-ton motor trucks travelling along it, and these heavy vehicles went along it as easily as a buggy might. The main roads had all been constructed by Napoleon in his wars, and they had been kept in splendid repair until this war started, but after the commencement of hostilities some of them had not been kept up. In the road repair work men who had been wounded were often employed instead of being sent back to the trenches, so that they would have less hardship, having a barn to sleep in, where they could keep warm and dry. The roads up to within twelve miles of the lines were in good shape. Beyond that they were in varying conditions, some of them bad and some good. The supplies were brought up by trains to some distance behind the trenches, and were then placed on very large motor trucks and brought to within six miles of the line. After that they were transported in wagons drawn by mules, sometimes over fields, still closer to the line, and then on the backs of the mules, being finally taken by the soldiers themselves and delivered in the trenches. This appeared to be the only safe way of bringing up the supplies.

The roads could be repaired during the day, and on this work the British Government employed a number of Belgian refugees, whom they paid at the rate of 60c. The method of repairing was to cut down trees and having cut them into cordwood of a suitable size, place them on the ground, laying over them red sand, and on top of that granite blocks six inches or eight inches by four inches. The roads were very well drained with drains six or eight feet deep. When blocks sank down they were raised with a crowbar and clay put under them and red sand placed on top. A brush was then taken and the sand swept off and thrown over the side of the road.

About May 1 the British army had commenced building new roads up to the trenches. All the roads which had been originally laid did not lead from village to village, but from chateau to chateau, where the baron or lord of the district had lived. The C.P.R. construction battalion and the engineers had succeeded in laying a road within a mile of the lines. By building at night and using a carpet colored with green and brown paint to cover it, they had been successful in hiding their work from the observation of the German aeroplanes.

Deputy Minister of Highways

Mr. W. A. McLean, Deputy Minister of Highways of the Province of Ontario, in his address before the convention, dealt with the road situation in the province, making particular reference to the benefits to be derived by counties operating under the Ontario Highways Act. With regard to the proposed system of provincial highways, he said that the scheme would provide that every part of the province would be served fairly in proportion to its traffic requirements, and that they should not carry away the impression that it was merely the intention to build one main highway across the province. He believed that the year 1917 would see substantial progress in regard to the adoption of county road systems. The counties which were hesitating believed that the undertaking was too big and would mean a heavy expenditure. They were liable to think that in assuming the improvement of, say, 200 miles of road, they must have the necessary money ready to pay out immediately. This was wholly a mistake; a county did not carry out the good roads' system in one year, and therefore they did not have to finance it in one year. Any county in Ontario could, by adding 1½ mills to their assessment, provide for a proper system of road improvement. They did not have to construct new highways, but only to improve and maintain roads according to the traffic over them, and from the time that they assumed the system the subsidy of 20 per cent. for repair work was granted by the government, while if it were found necessary to build a bridge or build a mile or two of highway, 40 per cent. of the cost would be borne by the province. The government did not dictate to them how they must build their roads, but they could carry out whatever class of construction they wished.

The Deputy Minister advised that the people of Ontario should not at the present time make heavy expenditures for road work, but that the counties should organize now and that they would just be in good shape to carry on work next year or the year after, and thus provide employment for the soldiers who are returning from the front. In conclusion Mr. McLean said that he hoped in the near future to go through every county of Ontario and discuss with them their county road systems.

President of the Dominion Association Speaks

Mr. J. Duchastel, president of the Dominion Good Roads Association, visited the convention and was requested to address the delegates. He said he felt that the Dominion association should not interfere with any work undertaken by any local good roads association, but that it was their duty to help on any provinces which have not such an organization. In the past year they had assisted in the initiation of a good roads association in Nova Scotia. The Dominion Good Roads Association was also desirous of impressing on the public at large the importance of the movement and they wished as well to impress the government with the fact that before very long vital problems in regard to the employment of returned soldiers and also of immigrants, would have to be dealt with. The soldiers would be coming home at a time when industries would be undergoing a re-organization, and there would be a very large number of men looking for work which might be provided by highway construction. Mr. Duchastel also drew attention to the fact that the Canadian and International Good Roads Congress would be held at Ottawa, April 10 to 14. He said there would be a number of papers that would be of interest to the people of rural districts, and that it would not be merely technical subjects which would be dealt with, so that the members of the local association might benefit by attending. He pointed out that the Dominion Good Roads Association had now applied for a charter in order that they might have a legal status and would be in a position to receive grants from the government to carry on their work.

Mr. Duchastel also told the delegates something of what had been done in the province of Quebec. The government, he said, had given, as aid to rural municipalities, $17,000,000 for the construction of roads, and the municipalities had expended about $7,000,000 over and above that amount. The province at the last session had also appropriated $5,000,000 more for road work. The municipalities were now compelled to maintain their roads up to a certain standard or the government would step in and carry out the work at their expense. In conclusion, Mr. Duchastel expressed his desire to see the construction of the Windsor to Montreal highway so that the people of Ontario might visit their neighbors in Quebec and that they might thus come to understand each other better.

Important Resolutions Carried

During the sessions, a number of important resolutions were passed, including the following:

That the association approve of the construction and maintenance, by the provincial government, of a highway from the Quebec line to Windsor and request that legislation be passed and the work undertaken as soon as the labor situation permits;

That the government include in the scheme for a highway from Windsor to Montreal, a branch to the Niagara River;

That the association approve of the action of the Highways Department in providing for research work in connection with the construction of highways to carry modern traffic;

That employment should be found for returned soldiers and others by the co-operation of the federal, provincial and municipal authorities in the construction of highways, and that a comprehensive scheme should be outlined without delay;

That the government be requested to place paving brick on the free list the same as asphalt paving material;

That the county councils be empowered to regulate the weight of loads drawn over their roads, at certain seasons of the year.

The association, as a deputation to the provincial government, presented their resolution at the parliament buildings, approving of the construction of the Windsor to Montreal highway.

A resolution of condolence was also carried and will be forwarded to the bereaved families of the members of the association who passed away during the year, namely, the late Major Sheppard, of Queenston; Mr. H. A. Bowman, clerk of Waterloo county; Mr. A. M. Chapman, clerk of Hastings county, and Mr. Beam, of Beamsville.

Election of Officers

The following are the officers elected by the association for the coming year: Honorary presidents, J. A. Sanderson, of Oxford Station, and S. L. Squire, of Waterford; president, C. R. Wheelock, Orangeville; first vice-president, J. J. Parsons, Caledonia; second vice-president, W. H. Pugsley, Toronto; secretary-treasurer, George S. Henry, M.P.P., Todmorden; directors, K. W. McKay, St. Thomas, Major T. L. Kennedy, Dixie, L. E. Allen, Belleville, F. A. Senecal, Plantagenet, D. Clow, Mallorytown, and W. W. Anderson, Picton.

Highways of the Eastern States

By Lucius E. Allen, C. E.*

A COMPARATIVE study of the good roads question as affecting our own requirements in the Province of Ontaro may well include some observations as to the good road movement in some of the states adjacent to or in close proximity to our province.

The conditions of climate, soil, population, character of traffic, etc., in some of the Eastern states are more nearly analogous to those existing in the province of Ontario than any other portions of this continent, and more especially than those of Great Britain. In the states of New York, New Jersey, and Pennsylvania, and some of the New England states, there exist similar varying conditions of climate—cold winters and hot summers; all the varying classes of soil from clay to sand; densely populated sections and sections sparsely settled, with correspondingly light traffic requirements, so that a careful study of the good roads development in those states should lead, perhaps, to information of value to those interested in the continued improvement of our provincial highways.

Highways of New York

The highways of the state of New York are, perhaps, on account of their touchng Ontario on both the eastern and western extremities of Lake Ontario, more familiar to this province than any of the other Eastern states, and for this reason first mention will be given to the state of New York. The topography of the state, as well as its geological formation, is quite similar in many respects to that of Ontario, ranging from sandy plains similar to the western portion of Ontario to extremely hilly country such as is found in the eastern and more northerly portions of Ontario. The population, according to the 1910 census, of a total of over 9,000,000, was distributed as follows: New York City, 4,766,883, or 52.3 per cent.; cities and towns, 7,185,494, or 78.8 per cent. It is, therefore, quite obvious that in the development of the New York state good roads movement, which started about the year 1898, the large proportion of its population residing in cities and towns, has had a distinct effect in determining the policy of the good roads development within the state. Under the first good roads law enacted, 50 per cent. of the cost of highways was borne by the state, 35 per cent. by the counties, and 15 per-cent. by the towns through which the roads passed. On completion the roads were maintained, under state supervision, at the expense of the town. It was found that this system was defective, inasmuch as the degree of maintenance of the different highways depended to a large extent on the wealth of the particular town or district as well as the efficiency of the town officials.

In 1913 the system was changed, a reorganization of the state highway department being effected, which system is at present in force. The state commissioner of highways, who is appointed by the governor for a term of years, has general supervision of all highways and bridges within the state that are constructed, improved, or maintained wholly or in part by the funds of the state. The state is divided into nine divisions, each division under a division engineer, who is in direct charge of all construction or maintenance road work, under the department of highways. There are two funds provided for highway work, one held by the state treasurer, the other deposited with the various counties. The former fund is obtained by the sale of highway improvement bonds; the latter is appropriated directly from the revenues of the state.

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*County Engineer, Hastings County, Ont.

Classification of Roads in New York.

The state highways are divided into four groups, of which brief mention will be made:

1. State Highways.—All highways classified as state highways are those built at the entire expense of the state. They are laid out and built in well-defined routes to serve and connect the most populous portions of the state. The mileage at present is about 3,800 miles, divided into 45 routes, as specified by the state legislature. The original cost of construction is entirely borne by the state, but their maintenance is paid for by both the state and the towns through which they pass. These highways are considered to be of the highest class of construction, and receive in most cases heavy traffic, especially motor traffic.

2. County Highways.—The so-called county highways are constructed at the joint expense of the state and counties. They correspond in most respects to what are termed in our province as main market roads. They constitute at present 8,380 miles of the state highways system. Maintenance is borne in a similar manner as for state highways, jointly by the state and counties.

3. County Roads.—The county roads are built at the sole expense of the counties, and are under the direct jurisdiction of the counties. Although the county provides the entire funds to construct its county roads, the state assists in their maintenance, to an amount equal to approximately 50 per cent. of the counties' appropriation for the previous year. This state aid is limited, however, to an amount not exceeding one-tenth of one per cent. of the counties' taxable property for any one year.

4. Town Highways.—Such highways as are all outside of incorporated villages and cities which do not belong to either the state or county system or to the county road system are included under and termed town highways. They are constructed and maintained jointly by a state and township fund. Any township desiring state aid for township roads must make a tax levy for such an amount that, added to the state's contribution, will be equal to not less than $30 per mile. Townships which are more sparsely settled and have a taxable valuation of less than $3,750 per mile may still receive state aid, based on a requirement of $4 per thousand of assessed valuation. The whole is graduated and regulated on a basis of the wealth per mile in the township. There are at present some 73,000 miles of township highways in the state that are receiving state aid and state supervision, of which 9,000 miles are constructed of heavy gravel or macadam, and they are being constructed at the rate of about 800 miles per year. It is estimated that seven-tenths of the agricultural products of the state are transported over these roads.

Pennsylvania's System.

The state of Pennsylvania, like New York state, is a very populous state, ranking second in population, much of its population, however, being concentrated in large cities. It early developed a well-organized state highway department, along somewhat similar lines to that of New York state.

There are at present 375 main highway routes or highways, covering over 10,000 miles, which are designated as state highways. All highways coming under state control are constructed at least 12 feet in width. No telegraph, telephone, electric light, or power poles can be erected on state highways without special permission from the highway department.

The state also grants aid to counties and townships upon application and on compliance with certain prescribed conditions equal to 50 per cent. of construction and also for maintenance. The basis of state aid depends on the mileage of the highways in counties or townships, the state contributing 50 per cent. and the county or township 50 per cent. for maintenance. The revenues derived from motor licenses is entirely applied to highway improvement. It may be of interest to note that the increase in expenditures on highways in Pennsylvania from 1904 to 1914 was 113.2 per cent. Of a total road mileage in the state of 91,555 miles there are 1,881 miles of macadam, 198 miles of bituminous macadam, 269 miles of brick, 235 miles of gravel, and 357 miles of other materials such as concrete, stone, etc., the balance being ordinary country clay or sand roads.

Roads in Rhode Island.

The state of Rhode Island, the smallest in area of the states, and smaller than many of our counties in Ontario, commenced a definite good roads policy in the year 1892. The state road system is at present in the hands of a Board of Public Roads, consisting of five members, each serving five years. The board have charge of the construction and maintenance of all state highways and bridges. Only such highways as are adopted and improved or reconstructed by the state board are considered state roads. There are at present 325 miles of state road, of which 89 miles are bituminous macadam, the balance being surface-treated water-bound macadam. All construction work is done under the contract system, and maintenance is largely carried out by the "patrol system." No convict labor is used in highway work within the state.

Road Policy in New Jersey.

The first state in the Union to adopt a policy of state aid was the state of New Jersey, the first work under the system being started in 1892. As it is one of the most densely populated, and in consequence one of the wealthiest per square mile of area, it requires a very extensive system of inter-connecting highways throughout the state. The cost of reconstructing the highway system has been high, owing to the necessity of straightening and reducing grades on many of the main highways, which originally in many cases followed the old Indian trails. For the size of the state its roads are probably more extensively used for motor traffic than any other state. In 1914, according to state registration, there was an average of one automobile for every forty of population, and six automobiles for every mile of road.

Sand-clay roads are constructed of gravel, engine cinders, etc., and cost about $1,000 per mile for grading and $1,000 for surfacing, or a total of $2,000 per mile. The average width is from 12 to 14 feet.

Gravel roads cost from $2,500 to $10,000 per mile, and range from 14 to 40 feet in width.

Macadam roads are usually over 12 feet in width, and cost from $5,000 to $20,000 per mile to construct. It is estimated that the total cost of roads in New Jersey will approximate $140,000,000.

The highways system is largely centralized in a state highway department, the state giving aid to both new construction and maintenance.

From the few brief facts which have been submitted it is apparent that the tendency in the states mentioned is towards increased aid, coupled with greater and more rigid supervision and inspection of all classes of public roads. The large revenues derived from motor traffic, which will necessarily increase from year to year, supplemented with funds from the state and from those directly benefited by improved roads, should help to solve the good roads question, a question which will be solved all the sooner by the greatest possible education of road users to the benefits to be derived from good roads in any country.

Benefits of County Roads

By C. R. Wheelock, C.E.

SYSTEMATIC and scientific road building was in practice by the Romans as early as the year 312 B.C. The roads then commenced culminated in a most wonderful system of stone paved highways stretching from Rome to all parts of the great Empire. This colossal system included 372 roads which are said to have amounted in length to 52,964 Roman miles, or about 48,690 English miles. Many miles of these roads still remain, bearing evidence to the skill of the Romans as permanent road builders.

France and England have admirable systems of paved roads which are the result of a revival in road building which commenced at the beginning of the eighteenth century. The United States began to improve some of her highways about the middle of the eighteenth century, but few paved roads were built for many years. A system of state roads has been commenced in the last decade and is going ahead so rapidly that it threatens to rival the gigantic system of the Roman Empire. And now Canada has entered a good roads era. Progressive legislation has been passed by the provinces and improved road building encouraged in every way. Ontario has been to the front in the movement and her progressive, intelligent and comprehensive good roads policy has accomplished wonders in a short time.

Roads are a Measure of Progress

Byrne in his "Highway Construction" says, "Countries inhabited by the least civilized people, whose wants can be supplied in the immediate vicinity of their dwellings, are almost destitute of roads; hence it has come to be said that roads are the physical symbol by which to measure the progress of any age or people. If the community is stagnant, the condition of the roads will indicate the fact; if they have no roads they are savages."

Before the advent of the motor vehicle the building and maintenance of rural roads were regarded as solely of rural concern and the good roads problem was almost entirely a local question. The chief function of the wagon road was to afford transportation between the farm and the nearest market town or railway station. But now the motor truck and the motor car, together with good roads, have brought better markets within reach of the producer, and besides, a large interurban traffic has been created for the conveyance of both goods and passengers.

The traffic, instead of being local, as formerly, is now very often through traffic, or traffic from outside of the municipality. I know some township roads where 75 per cent. of the traffic that passes over them is from outside of the township and therefore the road is used and worn out to that extent by people who, under the old system of taxation, would not be paying one cent towards the construction or maintenance. This, of course, is manifestly unfair. The basis of taxation must be that the cost shall be equitably levied on those who benefit. It is now fully conceded that urban municipalities should assume their fair share of the burden.

The Provincial Legislature, as the first step toward meeting the changing conditions, passed the Highway Improvement Act in 1901, and legislation has been added from time to time, keeping well up with the progress being made in road building and traffic conditions.

Government Share of Expenditure

The present legislation provides that a County Council may take from the township authorities for construction and maintenance a system of main or market roads. The province contributes 40 per cent. of the total expenditure for construction, or two-thirds as much as the county; that is, on a total expenditure of $100 the county raises $60 and the province contributes $40. And for maintenance the province contributes 20 per cent. of the total expenditure, or one-quarter as much as the county. This contribution by the government may be said to come indirectly from the motorists, in license fees, and may be looked upon as the tax paid by them for the use of the roads. The yearly tax for a small car would be $10, and for a big car $30. The average tax for the construction and maintenance of a county roads system is about 1½ mills on the dollar, which would be a yearly tax on the small farmer with a $3,000 farm of $4.50, and on a big farmer with a $10,000 farm of $15. It has been suggested that the money collected for motor licenses in each county be turned over to the county in which it was collected, there to be expended by them on the roads. This would simply be cutting off the amount contributed by urban license holders to support the rural roads, and as this would be about 90 per cent. of the total amount collected by the government for licenses, the change evidently would not work out to the interests of the rural taxpayer. The city of Toronto alone pays about $200,000 for licenses. The total amount collected by the province last year was about $650,000, and there is no doubt this will soon reach $1,000,000 annually. It is understood that all of this amount will be turned over for the improvement of rural highways under the regulations of the Ontario Highways Department. The present legislation apparently meets with the approval of the majority, 24 counties having assumed county road systems under the Highway Improvement Act.

Inadequacy of Road Work

The control of roads by the townships alone has not been satisfactory in building up a system of main market roads suitable for the existing conditions. It has been demonstrated that under the increased traffic the old roads and the old systems of road building are quite inadequate. It is a well-known fact that the roads in townships where there is no county system are deteriorating instead of improving. Main roads that would have stood up fairly well under the traffic of ten years ago are now worn out in a short time, and when the next best road is picked out, as it was built for even lighter traffic than the first, it wears yet a shorter time, and so what was formerly the best roads of the township soon become the worst. When main roads are properly constructed by the county they take the bulk of the traffic and allow secondary roads to be built and kept in good repair by the township at a moderate cost. It has been announced by the Minister of Public Works that legislation will be brought down at this session of the Legislature providing for an increased grant for main roads on county systems which take the interurban traffic. This increase is along the right line, and if the grant is increased to about 75 per cent. for construction, and the same for maintenance, as we expect it will be, no doubt the good fruits will be soon seen in the construction of a better class of roads and in better maintenance.

The increase of traffic on the highways calls for an increased expenditure, but is a sure sign of the progressiveness and business activity of the community. A road that is not used is surely idle land from which the public derive no revenue or benefit, but an improved road carrying much traffic is a rich asset, and its value increases as the traffic increases.

Not Necessarily an Increased Burden

A county road system does not necessarily mean an increased burden for the tax-payer. The roads assumed are, generally speaking, the most heavily travelled township roads, and therefore require a considerable expenditure for construction and maintenance in their present state. Suppose such a road is to be improved, and that the township provides the customary amount for township road construction, after this sum has been expended the government steps in and says, "This road is hardly good enough to carry the traffic, we will add 66-2/3 per cent. to the sum you have raised, which will be sufficient to make a first class road of it." It is evident that in this case the improved road would be built without extra cost to the township, and in some cases this would apply. And besides, for bridges and culverts built on the township road the township would have to pay the full amount of the cost, so it is evident there is a straight saving to the municipality of 40 per cent. of the total expenditure for bridges and culverts built on county roads. A further saving to the township would result from the decreased cost of maintenance of other roads from which the traffic would be drawn to the improved road. And as the Act now provides for the maintenance of winter roads the public have the advantage of a good road throughout the whole year.

Road Suited to Traffic

The regulations of the Highway Department are most reasonable; they do not insist on any particular class of road, only that the road shall be suitable for the traffic. The most economical road which can be built is the road that is suitable for the traffic that passes over it; this may be anything from an ordinary earth road to a concrete or brick road. The Department does, however, insist that the roads shall be properly constructed, from the foundation to the surface, which is undoubtedly a wise provision, and the most economical kind of construction. Road superintendents are instructed in all the principles of road building. An annual conference on road construction for county superintendents and engineers is held at the Parliament Buildings, Toronto. The experience and advice of the engineers of the Highway Department, under the able supervision of W. A. McLean, Deputy Minister of Highways, and Geo. Hogarth, Chief Engineer, is cheerfully given at all times. This assistance is very helpful to the road superintendents and is much appreciated by them. Road building is a science, and the road built under the supervision of a trained and experienced road builder must give the best results.

Eager to Have Systems Extended

There is no better proof of the benefits of county roads than the fact that in counties where they have been tried out the ratepayers are eager to have the systems extended. In the County of Peel, where county roads were assumed ten years ago, many miles have been added to the system first adopted, and the ratepayers are still asking for more. A short time ago a subscription list was started in the north part of the county and was headed by the owner of a 100 acre farm, with a subscription of $500, to be given to the municipality on condition that the main highway which runs past his property would be assumed as a county road and built in accordance with the regulations.

There seems to be in some localities a most exaggerated idea of the increased burden assumed by the ratepayers with a county system of roads. I have endeavored to correct some of the misconceptions in connection with this matter and to point out the many advantages accruing to the township municipality. The benefits have been considered from the viewpoint of the municipality only, but besides there are the many benefits to the individual such as:—Increase in the value of property; decrease in cost of haulage; a wider choice of markets; the marketing of produce at the most favorable times; and the promotion of social and intellectual intercourse between members of rural communities and also between rural and urban population.

Concrete for Sanitary Sewers

AT the annual convention of the American Concrete Pipe Association, held recently in Chicago, M. W. Loving, of the Universal Portland Cement Company, presented a paper on "Concrete for Sanitary Sewers" He gave a careful and interesting study of sewer systems as a whole, calling especial attention to the fact that many cities use concrete for their sewage disposal plants and for their main sewers, but that the smaller pipe house connections, etc., are, in the majority of cases, given over to other materials. He pointed out the great field there is for the smaller sizes of concrete pipe, and also touched upon the matter of acids in sewage, in this connection saying that even if engineers are afraid of corrosion from such acids, the effect of these would be greater on the larger sizes of pipe, because these results do not begin to develop until after the sewage has passed out of the house connections into the main sewers.

Comparison of Activated Sludge and Imhoff Tank-Trickling Filter Processes

THE activated sludge process, during the past two years, has taken a prominent place among methods of treating sewage, and there have been many investigations to determine its capabilities. The primary function of this process is the oxidation of organic matter through the agency of bacteria living in the presence of an ample supply of oxygen. As this is the primary function of the trickling filter also, it is important to know which is the more advantageous process. This can only be determined by a comparison of the respective costs of the two processes and an analysis of their individual advantages and disadvantages. In making such studies the local conditions in each case must be given their merited weight. In the comparison discussed in this paper by Harrison P. Eddy, before the Western Society of Engineers, and published in their Journal, the problem has been applied to the conditions existing at Fitchburg, Mass., a city of 40,000 population, where an Imhoff tank-trickling filter plant has been in successful operation since October, 1914.

Two Comparable Plants

The following discussion of construction and operation costs is based on studies of two treatment plants, one for the Imhoff tank-trickling filter process, and the other for the activated sludge process, both plants being designed to fulfill the same conditions. The trickling filter plant has been based on the design and cost of the plant at Fitchburg, Mass., with such modifications as are necessary to reduce the costs to units suitable for comparison. The activated sludge plant has been designed to meet the same conditions, and where possible, the same unit costs of construction have been employed. The design has been based upon experience gained from several experimental installations operated by the author during the past year and from data procured from Milwaukee and other reports.

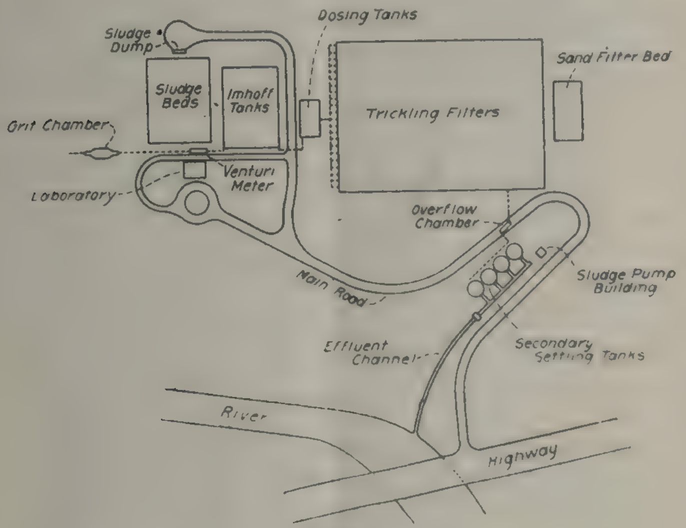

Fig. 1

Fig. 1.—Plan of typical trickling filter plant for sewage treatment.

Both plants have been designed to care for the sewage from a population of 55,000 persons. The average quantity of sewage is assumed to be 100 gals. per capita per day, equivalent to 5,500,000 gals. per 24 hours, and the detention period in Imhoff and humus tanks has been based upon a day-time flow of 125 per cent. of this average.

Fig. 1 shows the arrangement of the Imhoff tank-trickling filter plant, the design being based on that at Fitchburg, the only material modification being to increase the size of the trickling filters and dosing tanks to serve a population of 55,000 instead of 40,000 persons. The remainder of the plant was built to serve a population of 55,000.

The plant for the activated sludge process, shown in Fig. 2, has been designed, as far as possible, to meet the same conditions as those for which the trickling filter plant was built. The same type of structures has been used where applicable and an effort has been made in every way to make the two plants strictly comparable, both being designed to serve 55,000 persons.

Cost of Construction

The cost of the trickling filter plant, as already stated, has been based on the unit costs of construction of the trickling filter plant at Fitchburg, Mass., which was built by contract, bids being received in May, 1913. Cost figures obtained in this way are more nearly representative of normal conditions than if based on the high cost of construction prevailing at the present time. As far as possible the same unit costs of construction have been applied to the estimates of the activated sludge plant, that the two estimates may be comparable.

Trickling Filter Plant.—The estimated cost of the trickling filter plant is given in Table 1. In addition to the main features, a number of items are included which go to make up the complete plant. It should be noted that the amount included for cost of land, includes not only the land required for the treatment plant, but a total area of about 117 acres, sufficient not only for all purposes of sewage treatment, but also more than sufficient to properly isolate the plant. Under miscellaneous work are included such items as extension of the water supply, electric lighting system, and other features of minor importance not covered by the principal items. It is expected that for a plant of this character administration charges may easily amount to three per cent., and engineering to twelve per cent., making a total of fifteen per cent. to be added for these items. The total estimate of the Imhoff tank-trickling filter plant for a city of 55,000 populations, is $431,710. This is equivalent to $7.85 per capita, or $78,500 per million gallons per day for the assumed flow of 5.5 million gallons.

TABLE 1

Estimated Cost of Imhoff Tank-Trickling Filter Plant

	Cost excl eng'g and administration, total	Unit cost excl eng'g and administration per capita	per m g d
Grit and Chamber Screen	$ 10,000	$0.18	$ 1,818
Venturi Meter Chamber	3,000	.05	545
Imhoff Tanks, including Air Lifts for Sludge	64,500	1.17	11,720

Air Compression Equipment .	800	.01	145
Sludge Beds, incl. underdrains	4,800	.09	873
Trickling Filters 10 ft. deep (2.75 acres)	188,500	3.43	34,300
Dosing Tanks and Apparatus.	16,600	.30	3,020
Secondary Settling Tanks	9,000	.16	1,637
Sludge Pumping Equipment and Building	2,000	.04	364
Conduits and Pipe Lines, including Overflow	10,600	.19	1,925
Effluent Channel	1,300	.02	236
Roadways	9,100	.17	1,655
Laboratory Building and Equipment	15,200	.28	2,762
Grounds, Trees, Planting, etc.	1,700	.03	309
Miscellaneous Work, 4 per cent. of total, excluding land	13,300	.24	2,420
Land	25,000	.45	4,550
Total	$375,400	$6.81	$68,279
Add 15 per cent. for Engineering and Administration ...	56,310	1.04	10,221
Grand Total	$431,710	$7.85	$78,500

For 55,000 persons equals $7.85 per capita.
For 5,500,000 gallons per day equals $78,500 per m. g. d.

Activated Sludge Plant.—The estimated cost of the activated sludge plant is given in Table 2. In addition to the features already described, it will be noted that several items have been included to make the plant complete. As stated in the case of the trickling filter plant, the item of $25,000 for land includes about 117 acres. It may not ultimately prove necessary to isolate the activated sludge plant, in which case a credit in favor of this plant should be made on account of the small area of land required. In this case, as in the other, fifteen per cent. has been added to cover the cost of administration and engineering charges. It will be seen that the total cost of the activated sludge plant is $313,880, which for a population of 55,000 persons is equivalent to $5.71 per capita, and $57,100 per million gallons per day.

TABLE 2
Estimated Cost of Activated Sludge Plant

	Cost excl. eng'g and administration, total	Unit cost excl. eng'g and administration per capita	per m. g. d.
Grit Chamber and Screen ...	$ 10,000	$0.18	$ 1,818
Venturi Meter and Chamber..	3,000	.05	546
Sewage Aeration Tanks	78,100	1.42	14,200
Sludge Aeration Tanks, including Air Lifts	17,500	.32	3,180
Sedimentation Tanks, including Air Lifts	8,300	.15	1,510
Air Compressing Equipment..	22,600	.41	4,110
Air Meters—2	700	.01	127
Air Washer—1	600	.01	109
Power House	29,700	.54	5,400
Sludge Beds, incl. Underdrains	31,400	.57	5,710
Conduits, Pipe Lines and Overflow	10,000	.18	1,818
Effluent Drain	1,300	.02	236
Roadways	8,300	.15	1,510
Laboratory Building and Equipment	15,200	.28	2,760
Grounds, Trees, Planting, etc.	1,700	.03	309
Miscellaneous Work, 4 per cent. of total, exclusive of land ..	9,540	.17	1,735
Land	25,000	.45	4,540
Total	$272,940	$4.94	$49,618
Add 15 per cent. for Engineering and Administration	40,940	.77	7,482
Grand Total	$313,880	$5.71	$57,100

For 55,000 persons equals $5.71 per capita.
For 5,500,000 gal. per day equals $57,100 per m. g. d.

Cost of Operation

Trickling Filter Plant.—An estimate has been made of the cost of operation of the trickling filter plant, based principally on the experience at Fitchburg, for the years 1915 and 1916.

The estimate of annual operation cost of the hypothetical Imhoff tank-trickling filter plant to serve a population of 55,000 is given in Table 3.

TABLE 3
Estimated Annual Cost of Operation of Typical Imhoff Tank-Trickling Filter Plant

General, including Administration	$ 2,200
Laboratory	1,700
Grit Chamber	1,650
Imhoff Tanks	3,120
Trickling Filters	2,020
Secondary Tanks	1,650
Sludge Beds	1,470
Care of Grounds	1,250
Miscellaneous	2,020
Total	$17,080

5.5 m. g. d. equals 2.005 m. g. treated equals $8.50 per m. g.
55,000 persons equals $0.31 per capita.

Activated Sludge Plant.—The estimated annual cost of operation of the activated sludge plant is shown in Table 4. Nearly half of the annual operating cost is for electric power, required for compressing the air. It was estimated that in addition to the air required for sewage aeration one-fifth as much would be required for sludge re-aeration and for operating the air-lift pumps. The total annual cost of operation amounts to $40,140, which is equivalent to $20 per million gallons treated, or 73 cents per capita, based on 55,000 persons.

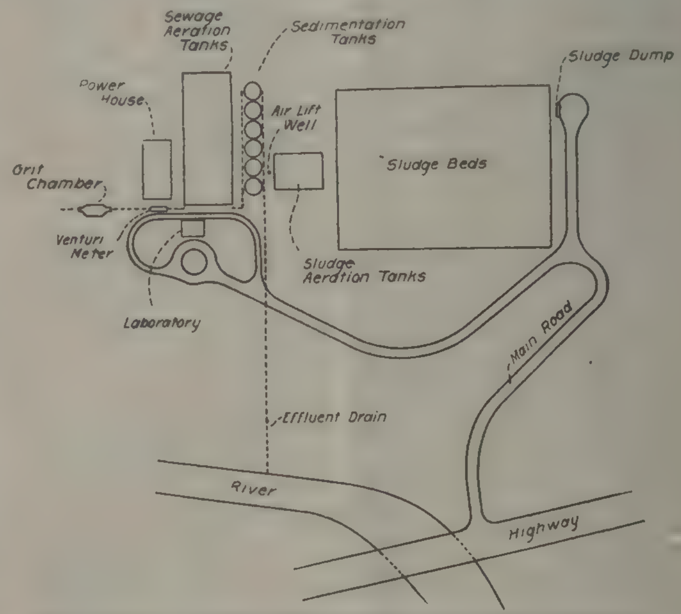

Fig. 2.—Plan of a typical activated sludge plant for sewage treatment

The item for power is estimated on the assumption that it can be obtained at 1c per kw.h. For many places this is a low price, while for others it is high.

TABLE 4
Estimated Annual Cost of Operation of Typical Activated Sludge Plant

Item		Annual Cost
General, including Administration		$2,200
Laboratory		1,700
Grit Chamber		1,650
Tank Treatment—		
1 Engineer foreman at $4 per 8-hr. day, 312 days.	$1,248	
3 Engineers at $4	3,744	

4 Laborers at $2.50	3,120	
Repairs	1,278	
		9,390
Sludge Drawing and Disposal—		
Foreman part time	$ 375	
2 Laborers at $2.50, 312 days each	1,560	
1 Team at $6, 312 days	1,872	
Supplies and Repairs	603	
		4,410
Electric Power at 1c per kw.h.		17,040
Care of Grounds		1,250
Miscellaneous		2,500
Total		$40,140

5.5 m. g. d. equals 2,005 m. g. treated equals $20.00 per m. g.
55,000 persons equals $0.73 per capita.

Comparison of Costs

For the final comparison of costs the interest and depreciation have been computed for both plants, and the total annual cost, made up of operating expenses and interest and depreciation, has been capitalized at four per cent. and added to the construction cost, Table 5. The result is decidedly in favor of the Imhoff tank-trickling filter plant, in spite of the fact that the estimates of operation of the activated sludge plant have been kept low, probably lower than is justified, that there might be no danger of inflating this cost to the disadvantage of the new process. To eliminate this difference it will be necessary to decrease the operating expenses of the activated sludge treatment by about $11,000, or to decrease them a portion of this amount and in addition thereto to decrease the construction cost materially.

TABLE 5

Comparison of Costs of Imhoff Tank—Trickling Filter Plant and Activated Sludge Plant

Item	Trickling Filter Plant	Activated Sludge Plant
Operating Expenses	$ 17,080	$ 40,140
Interest and Depreciation*	26,760	19,780
Total Annual Cost of Treatment	$ 43,840	$ 59,920
Total Annual Cost of Operation per m. g.	21.84	29.85
Total Annual Cost of Operation per capita	0.80	1.09
Expenses capitalized at 4 per cent.	1,096,000	1,498,000
Construction Cost	431,710	313,880
Total	$1,527,710	$1,811,880
Difference		284,170

*Interest at 4 per cent.—Depreciation—Sinking fund at 2½ per cent.

At the present time much attention is being given to methods of converting the sludge into marketable fertilizer. There is reasonable agreement among investigators that activated sludge contains a greater proportion of fertilizing ingredients than the sludges obtained from most other processes of sewage treatment. If the sludge can be converted into commercially dry powder containing only 10 per cent. moisture, there is good evidence of a market for it at a moderate price.

If the cost of preparation and sale of sludge should be no more than the return from such sales, the reduction in the foregoing estimates of operation and construction would be $5,030 and $36,000 respectively. If this process should be even more successful and a net profit of $2.00 per ton, or say $1.00 per million gallons should be derived, the saving thus effected would amount to—

Profit on sludge	$2,007.50
Cost of sludge disposal as per previous estimate	5,030.00
Interest and depreciation on sludge beds	2,270.00
Total	$9,307.50

In addition to this annual saving there would be also the saving in investment cost of $36,000.

Even this profit and saving would not be enough to reduce the cost of the activated sludge process to that of the Imhoff tank-trickling filter process, but the net profit of $1.00 per million gallons may be substantially exceeded. In any event, this subject should receive, as indeed it is receiving, most careful investigation.

In spite of the fact that it appears to be somewhat more expensive than other processes, the activated sludge treatment should not be rejected on the ground of cost without giving full consideration to its advantages. It may be that as an oxidizing process it will always be more expensive than the trickling filter, but it may have advantages more important than this disadvantage.

Relative Areas of Land

If it is assumed that the sludge from the activated sludge process is to be dried and disposed of by means of sludge beds, the total area of land used for the activated sludge plant will not differ greatly from that actually used for the trickling filter plant.

The estimated area required for the typical activated sludge plant is ten acres, or nearly two acres less than that required for the typical trickling filter plant, which is estimated at 11.8 acres. If some other form of sludge disposal were used, the area would be materially reduced. As already stated, the activated sludge plant may have some advantage in not requiring as much land for isolation as the trickling filter plant. The corresponding reduction in cost would be to the advantage of the former.

Loss of Head Necessary in Plant

One of the important advantages of the activated sludge process is the small loss of head required for the passage of the sewage through the plant. The resulting saving in cost of sewerage works such as pumping stations and long outfall or intercepting sewers, may be sufficient to make the adoption of the activated sludge process imperative.

Odors

There is some sentiment hostile to an Imhoff tank-trickling filter plant because of the fear of the dissemination of objectionable odors. That objectionable odors are noticeable in the immediate vicinity of such plants cannot be denied. On the other hand, there is good evidence that they are not noticeable except very close to the treatment plants.

The activated sludge plant appears to have some advantage in this direction. Odors may be noticeable in the immediate vicinity of the aeration tanks, and it is possible that objectionable odors may be given off from some portions of the sludge drying and handling process, whatever it may ultimately be. It is probable, however, that the danger from this source will be less than from the Imhoff tank-trickling filter plant.

Moth Flies

The moth flies, so prevalent at certain seasons of the year, are quite objectionable close to the filters, although they are rarely found more than a few hundred feet away from them. While this cause of annoyance may be kept under reasonable control, it is doubtful if it can be wholly eliminated. The activated sludge plant does not seem to be a suitable breeding ground for these pests, and therefore has an advantage over the filter.

Quality of Effluents

There is no doubt that the activated sludge process is capable of producing a more highly oxidized effluent than the trickling filter, as ordinarily built and operated, that it will eliminate a much greater proportion of bacteria, and that in appearance its effluent will be decidedly superior to that of the filter. This is a marked advantage under certain circumstances, but these facts alone should not be allowed to control in the adoption of a more expensive process when the accomplishments of the trickling filter answer all purposes.

Complexity of Activated Sludge Process

A disadvantage of the activated sludge process in the minds of many who have studied it is its apparent complexity and need for careful and skillful supervision. While it has been contended by some that this process is exceedingly simple and one which can be operated by a workman of ordinary intelligence, the consensus of opinion appears to be to the contrary. The author's experience in operating several small experimental plants, leads him to feel that of all processes of sewage treatment in practical use in this country today this is by far the most difficult to operate and that it will require the skill of a well trained engineer or chemist to insure continued satisfacory results with it.

Conclusions

At the present time it appears that the Imhoff tank-trickling filter process is a less expensive means of oxidizing the organic matter of sewage wastes than the activated sludge process, where oxidation alone is considered. If the areas of land required for isolation, the loss of head in the plant, the danger of objectionable odors and of the fly annoyance, and other disadvantages of the trickling filter process are of marked importance in any specific case the balance may be decidedly in favor of the activated sludge process, even in its present state of development.

The activated sludge process should receive, and is having, much study. There are many problems connected with it which may be solved in such a way as to put it in a much more favorable position. It is to be seriously hoped that investigations will go forward until the process is thoroughly perfected. In the meantime, also, further attention should be given to improvement in the design and operation of the older processes of sewage treatment.

Tests for Organic Impurities in Sand

DURING the past few years the subject of impurities in sands for mortar and concrete has been receiving rapidly increasing attention from testing engineers and inspectors. Experience has shown that on account of the presence of impurities, certain natural sands do not give satisfactory results when used in concrete, and many failures and much inferior work have been attributed to impurities in the fine aggregate. However, when it comes to determining before the sand is used in construction or subjected to tests in mortar, whether or not the sand is suitable for fine aggregate, there has been no well-established criterion regarding the impurities. Practically all specifications have required that the sand be clean; the so-called dirty sands have generally been in bad repute. Organic matter has been the principal source of trouble, yet many publications stating that as much as 10 per cent. of loam in sand was not harmful and might even increase the strength of the mortar, are to be found in the engineering journals.

An investigation initiated by Committee C-9 on Concrete and Concrete Aggregates, of the American Society for Testing Materials, showed the desirability of a simple and reliable test which would make it posable to detect sands which contained harmful impurities before they were used in concrete. Commercially, it was also desirable to develop some remedial measure which would make it possible to use sands which in their present condition, on account of impurities, are not satisfactory for concrete.

Unsatisfactory Methods

Engineers and chemists have recognized the danger of using sands which contained appreciable amounts of organic matter which may come from surface loam or other sources of contamination, and have used various methods for detecting such impurities. A method which has probably been most used depends upon the loss on ignition, but it is unsatisfactory. The determination of the organic matter by combustion has little advantage over the loss-on-ignition method, unless a correction be made for the carbonates present. Methods which depend upon the moist oxidation of the organic matter have some advantage, but are not entirely satisfactory. None of these methods determines directly the amount of organic matter in sands.

The colorimetric test for organic impurities in sands represents one phase of the work which has been done at the Structural Materials Research Laboratory, Lewis Institute, Chicago, under the direction of the committee mentioned above. This is the latest development in connection with the testing of sands and is described in a bulletin by Professor Duff, A. Abrams, and Oscar E. Harder, an abstract of which forms the basis of this article. The fact that the sand has passed the colorimetric test does not by itself prove that the sand is suitable for mortar or concrete, since its fitness and other characteristics must also be considered, as they affect the strength. The result of the researches, however, indicate that it is a reliable test for organic impurities, which are the most common source of danger in a sand of satisfactory granulometric composition.

The colorimetric test may be described briefly as follows:

A sample of sand is digested at ordinary temperature in a solution of sodium hydroxide (NaOH). If the sand contains certain organic materials, thought to be largely of a humus nature, the filtered solution resulting from this treatment will be found to be of a color ranging from light yellow up through the reds to that which appears almost black. The depth of color has been found to furnish a measure of the effect of the impurities on the strength of mortars made from such sands. The depth of color may be measured by comparison with proper color standards.

Two methods of procedure have been developed: (1) For field tests; (2) for laboratory tests. The field test only is described below.

Method for Field Tests

Fill a 12-oz. graduated prescription bottle to the 4½-oz. mark with the sand to be tested. Add a three per cent. solution of sodium hydroxide until the volume of the sand and solution, after shaking, amounts to 7 oz. Shake thoroughly and let stand over night. Observe the color of the clear supernatant liquid.

In approximate field tests it is not necessary to make comparisons with color standards. If the clear supernatant liquid is colorless, or has a light yellow color, the sand may be considered satisfactory insofar as organic impurities are concerned. On the other hand, if a dark-colored solution, ranging from dark reds to black is obtained, the sand should be rejected or used only after it has been subjected to the usual mortar strength tests.

Field tests made in this way are not expected to give quantitative results, but will be found useful in:

(1) Prospecting for sand supplies;

(2) Checking the quality of sand received on the job;

(3) Preliminary examination of sands in the laboratory.

An approximate volumetric determination of the silt in sand can be made by measuring or estimating the thickness of the layer of fine material which settles on top of the sand. The per cent. of silt by volume has been found to vary from 1 to 2 times the per cent. by weight.

The laboratory test aims to give quantitative results by accurate operations. The color comparison is carried out against a standard tannic acid solution and by calculation the color value is determined and expressed in parts of tannic acid per million of sand by weight.

Basis of Colorimetric Test

The colorimetric test has been applied to sands from about forty widely distributed deposits. The research to date has brought out the following:

1. Examinations of deposits of defective sands show that surface loam is the principal source of contamination.

2. All natural sands which have been found to be defective on account of the presence of organic impurities have responded to the colorimetric test with sodium hydroxide, and all sands which have given high color values have shown low values in mortar tests.

3. Sands which were similarly graded by screening out and recombining the different sizes to a definite sieve analysis, showed a fairly definite relation between the compressive strengths of 1:3 mortars at 7 and 28 days and the color values of the sands.

4. The mortar-making quality of sands known to contain organic impurities has been much improved by removing the organic matter, either by repeatedly digesting them with sodium hydroxide and then washing free from alkali, or by driving off the organic impurities by ignition.

5. When the sodium hydroxide extracts from sands which mortar tests had shown to be defective were purified and applied as coatings on high-grade sand, that sand was made "defective" or gave much reduced mortar strength.

Impurities in sands other than organic, such as clay or similar admixtures, if present in considerable quantities, may be expected to affect the strength of the concrete. However, the examination of a large number of defective sands has shown that it is the organic impurities of a humus nature which are responsible for the abnormally low strengths of such sands. The presence of these impurities can be detected by the methods described above.

It has been found that the colorimetric test can be made with a greater degree of uniformity by different operators than can the strength tests of mortars from the same sands, and inexperienced operators without technical training or previous experience in work of this character have secured satisfactory results at their first trial.

Joint Fillers for Granite Blocks

By Herman H. Schmidt[*]

IN this article, adapted from a paper prepared by the writer for presentation before the American Association for the Advancement of Science, a detailed statement of the requirements of ideal joint fillers is given, followed by a discussion of the various joint fillers used and available. In this discussion the defects in each are pointed out, and the writer suggests what in his estimation would be an ideal joint filler. There is also a brief discussion of methods for applying joint filler, and mention is made of the character of the cushion course which will give best results.

The writer's conclusion is that, with slight changes in the methods of work and improvement in the character of joint filler, granite pavement will have reached the highest state of development of which it is capable.

Granite Blocks Nearly Perfect.

The size and character of granite blocks, as now furnished by a number of quarries, are, in my estimation, as nearly perfect as we should require blocks to be. It is not necessary to enter into any additional refinements, so far as the blocks are concerned, because this would only add to their cost without increasing the perfection of the pavement. Improvements can be made in the methods of paving the blocks and in the character of the joint fillers.

I believe that all block pavements should be paved on as thin a cushion course as possible, depending, of course, upon the nature of the blocks, and this cushion course should be a mixture of cement and sand rather than sand alone. Joint fillers are still subject to much development, and at present we have no joint filler available which is ideal in all respects.

Requirements of Joint Fillers.

Cement grout joint fillers have been used for many years in this country as well as abroad, and I will point out later why, in my opinion, cement grout filler is not satisfactory, and why it is necessary to use a joint filler which has certain qualities that cannot be obtained from the cement grout. The characteristics of a good joint filler are:

It must (1) be durable; (2) be waterproof; (3) be of moderate cost; (4) be easily manipulated on the street; (5) flow freely into the joint and fill all the voids; (6) adhere firmly to the paving blocks; (7) hold the blocks firmly in place; (8) not change its consistency under varying temperatures; (9) not disintegrate owing to traffic or the action of temperature or under water, and there must be no chemical action take place between the joint filler and street refuse; (10) be somewhat elastic; (11) permit of easily removing the paving blocks without breaking them; (12) set up and harden quickly.

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[*] Chief Engineer, Bureau of Highways, Brooklyn

It is now admitted that no joint filler, whether a bituminous one or cement grout, will properly fill the joints and hold the blocks in place, if the joints are first wholly or partially filled with small stone or gravel. The granite blocks are now laid so close together that no particles of stone or gravel larger than three-eights or one-quarter of an inch will fall into the joint, and the voids in this very small aggregate are so slight that the proper penetration of the joint filler is prevented, and it is absolutely essential that the joint filler be uniform in density and strength from the top of the block to the bottom, if it is to do good service.

Coal tar and asphalt are the principal bituminous joint fillers used, but if these substances are used without the admixture of some mineral aggregate they have insufficient stability to properly hold the blocks, and therefore we mix fine, hot sand with them before the joint filler is placed in the joints.

Principal Joint Fillers.

The principal joint fillers for granite block pavements are as follows: Portland cement grout; a mixture of asphalt and sand; a mixture of coal tar and sand; a mixture of asphalt and coal tar with sand.

I will now point out where each one of these joint fillers fails to meet the conditions, which I have before stated are required for a good joint filler.

Portland cement grout fulfills practically all of the conditions required, except the following: (a) It is not elastic; (b) it does not readily permit of the removal of the blocks; (c) it takes too long to set and get hard.

Not being elastic, it does not provide for expansion, and unless the greatest care is exercised in mixing and applying the grout, the expansion causes a fracture of the surface of the blocks, which has, in many instances, almost ruined what were otherwise first-class granite pavements. On busy streets it is essential not only that a street be opened quickly to traffic, but also that repairs to the pavement be made available for traffic with as little delay as possible. As the cement grout requires from eight to ten days to set, patches in the pavement must be protected for that length of time, and on very busy thoroughfares it is almost impossible to protect them properly. In removing blocks many are broken, as we have practically a monolithic mass, and it is extremely difficult to make a neat patch. To take care of the expansion and also to stop vibration, a bituminous joint is sometimes placed between the curb and the pavement. There are a few notable examples of splendid granite pavements with cement grouted joints, but the failures are very much more numerous.

Asphalt and Sand Mixture Does Not Adhere.

The mixture of asphalt and sand fulfills the conditions I have imposed, with the following exceptions: (a) It does not adhere firmly to the blocks; (b) it does not hold the blocks firmly in place; and these faults are, of course, very serious ones. The writer has seen a slab of this joint filler actually pulled out of the joints, showing that it did not adhere to the blocks at all.

The mixture of sand and coal tar fails to comply with the conditions, in that it too readily changes its consistency under varying conditions of temperature The tar, if made very hard, will disintegrate; and, if made soft, will not stay in the joints, but flow toward the low places in the street. In either case the blocks become loose under certain adverse conditions, and are soon displaced.

The last filler mentioned—a mixture of asphalt, coal tar, and sand—comes, perhaps, as near fulfilling all the conditions which I have imposed as any filler which could be devised with the available materials. The addition of about 20 per cent. of hard asphalt makes the tar less susceptible to changes of temperature and greatly adds to its stability. It also enables a tar to be used which is not so hard as to be brittle. This filler has not been used to any extent, although some years ago such a mixture of tar and asphalt without the sand was used in connection with tar and gravel joints. Considerable experimentation is required to find the correct proportions of tar, asphalt, and sand to give the desired results, and the writer believes this joint filler should be given an extended trial by all those interested in obtaining the best results.

Prior to 1915 it was the general practice to carefully pour the joint filler into the joints, but this practice has now been superseded. The tar or asphalt joint filler must be constantly stirred in order to keep the sand in suspension, and it is very difficult to do this where the old methods of pouring cans was used. The practice now is to agitate the mixture constantly, either by hand or by other means, up to the moment that it is thrown on the surface of the pavement. It is then merely brushed or squegeed into the joints until they are full, leaving a thin skim of filler on the surface. This film on the surface protects the slight depressions in the top of the blocks, while it exposes the high places to the action of the traffic. The result is that by the time this surface coat is entirely worn off, the high places on the blocks are worn down, giving a smoother pavement than when first laid.

Some improvements in the methods of laying the blocks and in developing a more satisfactory joint filler are all that is required to bring granite pavement up to the highest state of development of which it is capable, so that, at least in this class of pavement, we know with some degree of certainty the amount of service we can expect to obtain from it.

Paving Problems.

It will only be a few years when horse-drawn vehicles will be entirely displaced by motor-drawn vehicles, and we will not then be subjected to the same criticism of our smooth pavements now arising out of the sympathy for horses.

If the weight of loads hauled by motor trucks is not curtailed by law (it is an open question whether or not it is wise to curtail this to too large an extent) then the pavement engineer must design a pavement to meet these enormous loads traveling at the rate of 12 or 15 miles an hour.

There are now a number of streets in New York City where heavy and speedy hauling has brought about conditions which are almost unbearable from many standpoints. New pavements which should last from fifteen to twenty years have been ruined in one year. These tremendous vehicles cause adjacent houses to vibrate and ceilings to fall, and people living along the street are made almost desperate by the danger, noise, and dirt from this traffic. Not one of our present-day pavements will withstand this extreme traffic, and it may become necessary, if we must provide for such traffic, to set aside certain streets for it, and to pave such streets with iron or steel, as the conditions more nearly resemble a busy railroad yard than an ordinary city street.

Clay Products in Engineering Construction

By E. H. Darling*

CLAY products perform many important services in all the various fields of constructive engineering. Their uses may not be as spectacular as those of some materials, but they are none the less most valuable. Clay, when properly treated, is a very poor conductor of heat and electricity, and very inert to chemical action, and most of its value in construction is due to these properties. The fact that it is a common material, widely distributed and found in a natural state, is because it is a stable chemical combination under all natural conditions of atmosphere and climate. When baked, burned, or fused, it undergoes certain changes which tend to make it even more stable or inert to deteriorating chemical forces. All such other materials, as the metals which are obtained by tearing them from the rocks by intense heat, or such as timber, which is built up by organic life, while stronger, harder, and more elastic than clay products, are not as stable, and they always have a strong tendency to return to their original state—to rust, decay, soften, and disintegrate.

Clay Products Solve Difficulties.

It is not a difficult matter to design a retaining wall, assuming certain conditions of foundation and backing, yet probably, with the exception of dams, there is no class of engineering structure that has a larger percentage of failure than retaining walls. It requires better judgment—the outcome of experience—to so drain away the water which is likely to collect and alter the assumed conditions than it does to design the wall. The same thing applies to road building and to foundations in general. The electrical engineer would have no difficulty in high voltage transmission were it not for the problem of insulation. It would not be difficult to heat a building were the exterior walls perfect non-conductors of heat. All large sewers might be easily built of concrete, were it not for the fact that certain kinds of sewage disintegrates Portland cement. All the study and thought put into the steel framework of a skyscraper is rendered worthless in a few minutes if there has been carelessness in protecting it from fire. All these problems and many more like them, which in a sense may be called the finer problems of engineering, depend on clay products in the form of drain tile, insulators, brick, glazed tile, hollow tile, etc., for their solution. We use clay products for permanent construction, and where strength is essential we build a framework or skeleton of wood and steel, and protect them by a covering of the more durable material. It must be remembered, however, that what is true of clay applies more or less to certain other products of the earth, such as Portland cement, asbestos, mica, slate, etc., which also have their place in construction.

But while clay products thus perform many services in construction, the end has by no means been reached. There is room for improvement in the way they are utilized; there are doubtless new uses to which they could be put, and, besides, the demand for their use could be greatly increased. The following brief discussion will offer, from an engineering standpoint, a few suggestions along these lines.

Brick Inefficiently Used.

The clay brick is one of the oldest forms of building material, and one would think that it must have long since reached its highest possible efficiency. But common brickwork, as used to-day, when required to carry great loads, must be classed as a very inefficient material. Good, well-burned brick, has an average ultimate compressive strength of about 130 tons per square foot, but when it is laid in lime mortar in the usual way the average strength of the combination is not more than half of this (70 tons). Here is a waste of 50 per cent. of the strength of the brick. It is only by the use of cement mortar that the value of the brick can be developed, for strength of a wall depends on the strength of the mortar. Now, for any homogeneous material, such as steel, it is usually considered quite safe to allow a working stress up to one-fifth or one-fourth of its ultimate strength, but for brickwork conservative engineering practice does not permit more than one-tenth or one-twelfth (7 to 8 tons). Thus to carry a given load we have to use two or three times as much brickwork as we would if we could have the same confidence in it that we have in steel. This is a further waste of the strength of the brick.

But there are still other handicaps put upon the use of brickwork which are not necessary. In some cities the building by-laws will not allow even the conservative unit stresses given above, but fix the limit as low as four tons per square foot—about what is considered safe for solid earth. This means that in these cities, to carry a given load, the amount of brickwork must again be doubled.

Now, approximately half the cost of brickwork is for the labor required to lay it. In this country we expect to pay masons at a somewhat higher rate, in proportion, than that received by some other trades, because of the fact that there are four months in the year during which there is not much bricklaying done. In other words, we only use 75 per cent. of the available skilled labor of this trade. We are safe in saying, therefore, without casting any reflection on brick masons, that, from an economic point of view, bricklaying is not more than 80 per cent. efficient in Canada.

Great Waste in Brickwork.

Thus, for every dollar we spend for brickwork fifty cents is for materials and fifty cents for labor. For this latter half-dollar we obtain labor of which we only use forty cents' worth, and which it is possible, by the adoption of systematic methods, to reduce to a cost of twenty cents. We are, therefore, getting seventy cents' worth of brickwork for one dollar. But, as in some cities, we are required to use twice as much brickwork as we need for strength, in such cities we only get thirty-five cents' worth of strength for one dollar. The same by-laws will allow us to put about four times the load on plain concrete that is permitted on brickwork, and the cost of concrete in piers and walls is approximately the same as brickwork. So for one dollar invested in concrete we will get about twelve times as much strength as we would from the same spent for brickwork, assuming that we get 100 per cent. efficiency in the placing of the concrete.

These figures must not be taken too seriously, for they in no way express the true relative value of brick and concrete. They are given to emphasize the fact that there is room for improvement in the use of even the oldest of clay products, and that in order to successfully compete with other materials the highest standard of product and efficiency in workmanship are essential. They also illustrate the evil effects of unreasonable building laws.

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* Before Canadian National Clay Products' Association

Clay Products for Fireproofing.

In fireproof construction the principles of engineering are so greatly used that it is not more than necessary to mention the subject here. The desirability of this type of construction for large buildings is admitted by all. But we have reached a point where fireproof construction can be used with splendid results for moderate size residences running from eight or ten thousand dollars in cost and up.

In working toward this higher standard of building in which the construction features are entirely engineering, the engineer is closer to the manufacturer of clay products than the architect is. Those architects to whom the bulk of this class of residence work goes make no claim of being engineers, and it means a radical and expensive departure from their accustomed practice to undertake it. The owner, on the other hand, knows even less about it, and, even if inclined to consider it, is easily discouraged by a hint at a great increase in cost. This is a field for fireproofing materials that has hardly been touched as yet.

Changes in Wood Block Paving Practice

By Ellis R. Dutton*

IN the earliest years so-called experts said that the preservative oil for wood paving blocks had a tendency to distribute itself through the block, and also insisted on the necessity of extracting all the resin from the wood before treatment. To accomplish this last result steaming was resorted to. While the expected object was not attained, the practice was in itself good, and is now incorporated in modern specifications for the purpose of preventing bleeding, to secure a proper distribution of moisture throughout the block and to eliminate expansion troubles traceable to the laying of dry wood.

Many Preservatives Used.

For a while it was thought that the only point worth while paying attention to was the character of the oil, and all discussion turned about the selection of type. But more recently it has been proved that there are a number of oils or tars that are quite suitable for this use. In fact, the specifications adopted by the American Wood Preservers' Association permit the use of water-gas tar, which has no definite relation to creosote.

It has been claimed that the oils used about 1908 would not be stable and remain in the block. In the fall of 1916 we took up some blocks laid in 1908 and extracted the oil. On comparison with the original oil it was found that the residue above 355 degrees Fahr. was raised three points and the gravity was changed from 1.10 to 1.116. The blocks had lost about four pounds of oil per cubic foot, but there was still sufficient remaining in the timber to insure its preservation for a number of years to come. No decay was noted in the pavement.

Bleeding Traced to Bituminous Filler.

Experiments have been made in Minneapolis with the so-called non-bleeding blocks, sections of pavement of this type being laid with sand and others with ordinary pitch filler. The sand-filled sections showed almost no bleeding, only a block here and there showing oil on the surface. Blocks laid with bituminous filler, however, were in quite a bad condition as far as bleeding was concerned, but it is thought that this was due to the filler. In this connection there seems to be no difference in action between pitch and asphalt filler.

Expansion joints at right angles to the curb line have been given up. These joints were found to be a source of trouble only, and served no useful purpose. The angle with the curb at which block should be laid has been the subject of certain experiments in Minneapolis in 1906. The result indicates that blocks laid at 67½ degrees and at 45 degrees show less trouble from joint wear than those laid at 90 degrees. The value of one type or another of a pavement is largely economic. As to maintenance, no pavement is cheaper than wood block. It may be said that the average cost of repairs for the past ten years has not exceeded 0.1 cent per square yard per year, and there is no question as to the wood-block pavement surpassing all others as to noiselessness and low traction resistance.

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* Assistant City Engineer, Minneapolis, at American Road Builders' Association.

Inquiries for Factory Sites from U. S. Firms

It was stated at the Montreal Builders' Exchange that over 400 American firms have made inquiries lately as to sites for factories, shops, and warehouses in Montreal. If only a fair proportion purchase or lease sites, this will result in additional building and an increase of the population, either within the city limits or in outlying districts served by a rapid transportation service. It will also increase the demand for residences for the workers, of which there is now a shortage. It is claimed that factory buildings, etc., can be erected more cheaply and more expeditiously in Montreal than in any other city in Canada.

Montreal Controllers Adhere to Steel Sluices for Aqueduct

The controversy over the headgates to be used in connection with the Lasalle Bridge, to be placed at the intake of the aqueduct, has been decided by the Montreal controllers in favor of adhering to the steel sluices recommended by Mr. P. Mercier, the chief engineer. Messrs. M. J. Hutler and Percival St. George, who were consulted as to the plans, were in favor of the stop-log system, on the ground that they were cheaper and were suitable for the purpose. On the other hand, it was argued that steel sluices were more easily operated and more permanent.

Will Supply Pumps

The Canadian Fairbanks-Morse Company have secured the contract for a 25 h.p. F-M motor, direct connected to an F-M centrifugal pump for the corporation of Kitchener, Ont.; also a contract for a Goulds triplex pump, direct connected to an F-M oil engine and a motor driven centrifugal pump for the corporation of Bothwell, Ont.

Equipment Purchased

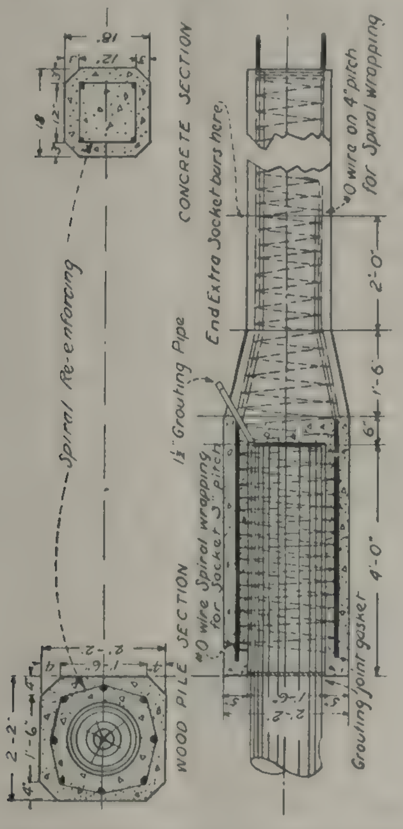
Mr. A. A. Scully, Stair Building, Toronto, has purchased the equipment of the Crown Portland Cement Company, Wiarton, Ont., and also the equipment of the Wilbur Iron Mines, Wilbur, Ont.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Concrete Pile Caps Wooden Pile for Salt Water Work

Wooden piles used in structures where it is necessary to have a portion exposed to water or mud have long since given trouble on account of the short life which may be expected of them. This is especially true in the case of piles exposed to salt water, where the various insects, well known to the owner of property near the ocean, carry on their work of destruction. The wooden pile is, however, as good a pile as can be had if it is kept entirely under ground. The objection to concrete piles is that if they are very long their weight is so great that it is extremely difficult to handle them during the driving process.



Details of concrete socket pile in place over end of wooden pile.

In order to combine the good qualities of both the wooden and the concrete pile, K. D. McLean, of San Francisco, Cal., has designed a pile which is intended to be used in the construction of piers and bridges, and which was described in Cement World.

This pile is built of reinforced concrete and has a socket at one end which is intended to fit over a woodpile, the object being to use the light wooden pile at the lower depths where its life will be long, and to expose the concrete portion of the pile to the mud and water. The ultimate life of the combined pile is very much longer than that of a wooden pile and the difficulty of handling the concrete pile is eliminated.

The length of wooden pile is determined so that when driven to the desired depth its top will be a foot or two below the mud line. This wooden pile is then driven to a depth such that the amount above the water line is a little more than required to fill the socket of the concrete part of the pile. A gasket of burlap is wound around the wooden pile at a distance from the top a little less than the socket depth, and the concrete part is raised into place, being held at a distance of about six inches from its position when clear on. The space between the wooden pile and the socket pile is then filled with grout through a pipe fitted into the socket for that purpose. A cap is screwed on the pipe and the socket pile is released, the pressure caused by its weight forcing the grout into all openings and firmly sealing the joint. The pile may now be driven home.

That the joint may be expected to hold has been shown by several tests made by the inventor. One case will indicate the results found: It was attempted to pull apart one of these combined piles which had been placed about a month. The driver used was equipped with an 8¼ x 10-inch double cylinder, triple-drum engine, and the pile was slung with chain and hook and the line passed through a pair of 3-sheave blocks and fastened to the hook of a single block, through which the engine runner passed, one end of which was fastened to the head block of the driver. After the mud had been washed away from the pile an hour was spent trying to pull the joint apart with the purchase just described, but the attempt was unsuccessful.

With the use of a floating driver, in connection with the apparatus already mentioned, the concrete pile was finally broken about three feet above the socket by repeated bending backward and forward. Another attempt was made to pull the concrete socket from the wooden pile, and it, too, was a failure.

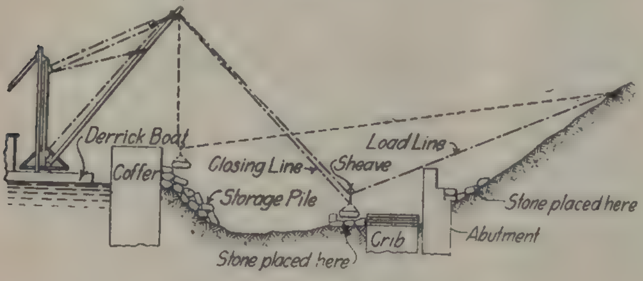
These tests indicate that the strength of the socket is at least as great as that of the entirely concrete pile. The socket pile has further proven its advantage over the older form in that the cost of installing this new piling is considerably less than that of concrete piling.

Heavy Riprap Handled with Derrick Boat Operating as Trolley

An arrangement for allowing a derrick boat with two lines to handle heavy riprap stone to a considerable distance beyond the reach of the boom by using one of the lines for a track cable and the other to manipulate a single-block trolley is described by G. W. McAlpin in Engineering Record.

The rig was used in connection with dam work to place a quantity of stone, which was not sufficient to justify setting up a derrick, in locations out of reach of derrick boats outside the cofferdam. The end of the load line from the three-drum hoist on the derrick was anchored to a deadman in the hill back of the abutment wall.

The trolley was made of a large sheave running this line with an iron strap on either side carrying chains and stone hooks. The closing line from the hoist on the boat was made fast to these straps and was used to check the load when it reached the required position. By carefully slackening both lines, the load line slightly more than the closing line, the load could be lowered accurately into place.



Derrick boat rigged to handle heavy riprap stones.

In operation, the boom on the derrick boat was raised to nearly vertical position. Many of the stones placed in this manner weighed as much as three tons, but were easily handled. As the derrick could readily be moved without unrigging the trolley, it was easy to cover a large area from one anchorage.

Old Salamanders Make Water Heaters

On many jobs hot water is required for various purposes and often a portable heater of some sort is more desirable than the usual makeshifts resorted to, which are more or less cumbersome. Old salamanders fitted with coils of 1-inch pipe, solve the problem very successfully. The coils can be easily fitted by the shop on the job. In use, the heater is connected to the water line by a hose, coupled to the lower end of the coil inside the salamander. From the upper end of this coil at the top of the salamander, a second hose is attached, with a cock to shut off the supply. An apparatus like this is a very useful device and can find application for dozens of purposes around almost any job. During very cold weather the heaters have to be drained when not in use, as the fires are liable to go out, causing the coils to freeze and burst. Cheapness is one of the favorable points about heaters of this kind.

Steel Company Organized

The Carbon and Alloy Steels Company, Limited, has obtained a Dominion charter with an authorized capital of $1,500,000. This company will erect furnaces and a foundry plant in Hamilton for the manufacture of steel castings, ingots, etc., by the Moffat electric process. The company will also take over the Moffat-Irving Steel Works of Toronto, which will be moved here and added to the new plant. Plans have been prepared by Prack and Perrine for buildings that will run into about $100,000. The main building will be 60 ft. wide and 400 ft. long, and subsidiary buildings will cover an equal area. Another $200,000 will be spent in furnaces, electrical equipment, conveyors, cranes, compressors, and other machinery. This plant when fully equipped will give employment to about 250 men and will have a gross capacity of 32 tons of molten steel per 24 hours.

The incorporators of the Carbon and Alloy Steels Company are: J. B. O'Brien, K.C., President Moffat-Irving Steel Works, Ltd., Toronto; H. J. Waddie, Esq., President the Canadian Drawn Steel Co., Ltd., Hamilton; J. W. Moffat, Esq., Vice-President Moffat-Irving Steel Works, Ltd., Toronto; John G. Gauld, K. C., Gauld, Langs & Crosthwaite, Hamilton; W. E. Vallance, Esq., late of Wood, Vallance & Co., Hamilton.

Calgary Branch C.S.C.E.

The regular monthly meeting of the Calgary Branch of the Canadian Society of Civil Engineers was held in the Board of Trade Room, City Hall, Calgary, on Thursday evening, February 15th. Mr. W. A. Lamb, associate member American Society of Civil Engineers, district engineer United States Geological Survey, Helena, Montana, gave an interesting address on "The Water Resources of Montana and Their Development." The meeting was well attended by the members of the local branch and a few of their friends. A. S. Dawson, Chairman of the Branch, made a very interesting report of the annual meeting of the parent society, which he attended in Montreal in January.

Agriculture and the Engineer

The Ottawa branch of the Canadian Society of Civil Engineers held their second luncheon for the year at the Chateau Laurier on March 1. The guest of the Society was Mr. Martin Burrell, who addressed the branch on the subject, "Agriculture and the Engineer."

Encouraging Imperial Trade

The Montreal Builders' Exchange have issued a circular to the members with a view to encouraging trade between Great Britain and Canada. It is asked that members who desire to take up agencies for British manufactured goods should supply the secretary with particulars of the class of goods to be handled, and also what class of British goods members are prepared to purchase for their own use. This information will be regarded as confidential.

Mainly Constructional

East and West—From Coast to Coast

The building permits issued in Welland, Ont., for the month of February this year are valued at $8,200, as compared with $380 in the same month in 1916. The total for the two months of the year is $10,715, as against $4,993 during the corresponding period last year.

Negotiations are under way between the council of Burnaby, B.C., and the Dominion Film Corporation, regarding the establishment of a motion picture plant at that town. The corporation wishes to obtain a site of 20 acres for the erection of a studio and necessary buildings.

The builders of the city of Hamilton, Ont., recently interviewed building inspector Whitelock, when the matter of having wider areas left between buildings being erected was discussed, and it was decided to have a by-law drafted to that end to be taken up by the city council.

At the annual meeting of the Board of Trade, of Cornwall, Ont., it was decided to petition the Ontario Government to include roads which exist in towns and villages, and which will connect with the proposed new Montreal to Windsor highway, as a part of the new highway scheme.

The estimates of City Architect Pearse, of Toronto, for expenditures in his department for the year 1917 total $68,389. This sum includes $500 for tests on big concrete jobs.

The Aetna Development Company, Limited, has been incorporated with a capital of $140,000, head office at Montreal.

The development of the Dewdney Mine on Sydney Inlet, by the Alaska & B. C. Metal Company, is now said to be proceeding rapidly. A 200-ton concentrator is being erected at the site. The same company is developing the Jumbo and Crow properties on Tofina Arm, an inlet of Clayoquot Sound.

An amendment to the building by-law has been passed by the city council of New Westminster, B.C. This amendment prohibits the erection of a shack, hut or cabin within certain specified areas in the city, a shack, hut or cabin being classified as a one-storey building having a floor area not exceeding five hundred feet.

In London, Ont., 21 building permits were this year issued during the month of February at a value of $18,305, as compared with 15 last year in the same month, valued at $18,765. The total for this year up to the end of February is 37 permits, value $32,740, while last year in the corresponding period there were 24 permits, value $37,995.

The Board of Works of New Westminster, B.C., is building a concrete arch for the protection of a pipe running under Columbia Street in front of the City Hall, which carries off the water from Herring's ravine, preparatory to filling in the old cedar culvert through which this pipe was laid. The object of this is to protect the vitrified pipe from the weight of the fill, sluiced down on it with the fire hydrants.

A deputation from the counties of Ontario, east of Toronto, recently waited on the members of the provincial cabinet and presented a request that the proposed highway from Windsor to the Quebec boundary should follow the route of the old Kingston Road from Toronto eastwards. The Premier and the Minister of Public Works, however, stated that the highway would be located to serve the best interests of the province and not under any political influence.

The Toronto Harbor Commission, which is constructing the foundation for the big steel plant at the foot of Cherry Street, for the British Forgings, Limited, have reported very favorable progress on the work on the foundations, which are of piles and concrete. They are rushing the job, and expect to be on the steel work by April 1. The steel plant will be a one-storey structure covering 30,000 square feet, and will have ten electric furnaces with a daily output of 300 tons.

It is stated that the Canadian Pacific Railway will save $256,000 annually on one item by the construction of its $12,000,000 tunnel under Rogers' Pass in the Rocky Mountains. Hitherto the trains over the mountains above the new tunnel were forced to run through four and one-half miles of snowsheds in winter. The 17,400 trains passing over this section of the road each year were always in danger of mountain rock, earth and snowslides, but with the new tunnel this will be remedied.

Legislation has been introduced in the Provincial Parliament of Ontario, by Hon. Finlay Macdiarmid, Minister of Public Works, providing that the government may designate as a provincial road any main road in a county system and to contribute a grant of 60 per cent. of the cost of construction. This would mean an addition of 20 per cent. upon the present grant. The road would then come under a measure of provincial control and would have a higher type of construction. These roads would draw the traffic from ordinary county and township roads and carry it to the big provincial highways.

The civil suit of the Province of Manitoba against Thomas Kelly and Sons, former contractors of the Parliament buildings, is to be settled out of court, by H. B. Hudson, Attorney-General. The government entered suit against the Kelly firm for the return of large sums of money alleged to have been over-paid on the buildings. The contractors disputed the government's claims and entered a counter claim for damages. By the settlement which has been effected, each party will name an arbitrator, and if they cannot agree as to the financial status of the contract, the matter is to be left to Robert H. Macdonald, of Ross & Macdonald, architects, of Montreal, for final decision.

The Victoria Museum at Ottawa, where Parliament now sits, has again shown signs of collapse. The building was erected in 1907 and ever since there has been trouble with the structure. Several years ago the building gave evidences of collapse and a body of engineers, after investigation, recommended certain alterations, among them the removal of the heavy front Norman tower. This was done, at an expenditure of some $15,000, and the building was reinforced. Now, however, the building is again showing defects. One corner has been found to be nearly two feet out of plumb. The corner is being reconstructed and strengthened so that there will be no danger of collapse when Parliament reassembles on April 19.

Since the old wooden bridge on Keith Road over the Capilano River has been condemned, the councils of the districts of North and West Vancouver have been conferring as to the provision of facilities for pedestrian traffic at least across the river at that point. In order that the residents in that section may reach the Capilano car terminals, it is proposed to erect a six-foot suspension bridge at or near the wooden bridge site, with towers at either end and stiffening cables from both banks. A proposition is also under way for a joint arrangement with the Capilano Timber Company which is building a bridge over the Capilano for its logging railway, providing for a bridge sufficiently wide to accommodate vehicular traffic and by means of a newly constructed road up the west bank of the Capilano make a connection with the Keith Road.

Personal

Lieut. J. E. Pringle, of the Royal Engineers, has been attached to the Indian army and left some time ago for the East. After a short stay in India he will proceed to Mesopotamia to join the Indian expeditionary force operating on the Tigris. Previous to enlisting Lieut. Pringle had been a student at the Faculty of Applied Science and Engineering of the University of Toronto. His home is at Hamilton, Ont.

Mr. M. A. Grainger, who has been acting chief forester for the province of British Columbia since Mr. H. R. MacMillan's appointment as lumber commissioner to study foreign markets, has now been appointed chief forester. Mr. Grainger, who is a graduate of King's College, Cambridge, England, came to Canada in 1897. He joined the Forestry Branch upon its inauguration and has occupied an important position in it ever since.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Aurora, Ont.
The consulting engineers, James Louden & Hertzberg, Excelsior Life Building, Toronto, presented report to the Town Council on Feb. 27 regarding sewage system. Scheme includes a collecting system, low level pumping plant, and disposal works at estimated cost of $87,600 . Work will likely start this summer.

Barton Township, Ont.
The Township Council are considering recommendation for the building of water tanks. Reeve, George Webb, Stinson Street, Hamilton.

Edmonton, Alta.
The City Council, engineer, A. W. Haddow, are considering the erection of an addition to filtration plant, consisting of a new liquid chlorine plant, four steel filters complete with equipment, and completion of the new clear water basin. Cost, $5,400.

The chairman and engineer, A. W. Haddow, has recommended to the City Council a sewer extension in the lane west of One Hundred and Twenty-seventh St., from One Hundred and Ninth Avenue to One Hundred and Thirteenth Avenue, to cost $7,100.

Harrow, Ont.
The business men plan to take up with the Township Council the question of paving Main Street in the spring. Clerk, J. H. Madill.

Lindsay, Ont.
Tenders will be received addressed to the Water Commision, Town Council, until noon March 15 for the erection of an addition to the pump house. Plans and specifications at the office of the engineer, Kerry & Chace, Ltd., 550 Confederation Life Building, Toronto, or at the office of the Water Commission.

Ottawa, Ont.
The Central Canada Exhibition Association, City Hall, will lay 4,874 square yards of Tarvia macadam roadway in the exhibition grounds. Clerk, J. K. Paisley.

Sarnia, Ont.
The citizens plan to petition the City Council for a cement pavement on London Road.

CONTRACTS AWARDED.

Lacolle, Que.
The Municipality of Notre Dame du Mont Carmel have awarded the general contract for the laying of cement sidewalks, to cost $5,000, to Laurin & Daigneault, Napierville, or Lacolle, Que.

Ottawa, Ont.
The Waterworks Department, City Council, have awarded Drummond, McCall Co., 28 Victoria Square, Montreal, the general contract for the supplying of valves.

St. Clements, Man.
The Rural Municipal Council, clerk, Thomas Munn, have awarded the contracts for placing 3,000 yards of gravel on the main highway to Cox & Macdonald and Mr. Hiencabuch.

Tecumseh, Ont.
W. Gauthier has been awarded the general contract for the erection of a $20,000 waterworks for the Eau Claire Waterworks Company, Ltd. Engineer, R. W. Code, Board of Trade Building, Windsor. Contracts for equipment will be awarded shortly.

Railroads, Bridges and Wharves

Alberta, Province of.
The Canadian Northern Railway, district engineer, Mr. Fraser, C.N.R. Station, Edmonton, plans to fence about 14 miles of right of way on Brazeau Line this year. Cost, $6,000.

Cornwall, Ont.
The Cedars Rapids Transmission Company, of New York State, president, F. A. Stoughton, Potsdam, N.Y., are considering the erection of a sub-station. Three thousand h.p. unit will be installed and additions made as required.

New Brunswick, Province of.
Tenders will be received by the Minister, B. F. Smith, Fredericton, N.B., Department of Public Works, Provincial Government, until noon March 21, for the erection of a bridge, "Perry Point." Plans and specifications at the Public Works Department, Fredericton; the Provincial Government Rooms, St. John; the residence of Mr. Hedley V. Dickson, M.L.A., Hammond River, King's County, and at the store of Mr. George B. Jones, M.L.A., Apohaque, King's County.

St. Tite, Que.
The Village Council are considering the erection of four bridges, costing $10,000. Engineer, J. E. Vallee, care of secretary-treasurer, J. Cloutier.

Ste. Ursule, Que.
The Municipal Council, secretary-treasurer, M. L. Louis, will call tenders during the summer for the erection of a steel bridge over the Maskinonge River.

CONTRACTS AWARDED.

Hamilton, Ont.
The Ottawa Contractors, Ltd., Catharine St. N., have been awarded the general contract by the Parks Board, City Council, for repairs to wharf at Wabasso Park, to cost $4,000.

Public Buildings, Churches and Schools

Amqui, Que.
The Roman Catholic congregation are considering the erection of a $75,000 stone church, and have appointed Thos. Raymond, 43 Carron Street, Quebec, architect. Tenders will be called in May or June.

Brampton, Ont.
The High School Board have decided to raise $60,000 by debentures for the erection of a high school. Chairman, Dr. J. G. Roberts.

Chauvin, Alta.
Secretary-Treasurer G. A. Woodward, Board of Education, is receiving tenders until noon March 10 for the erection of a school. Plans and specifications with the board or secretary-treasurer.

Dartmouth, N.S.
The erection of an $80,000 school is contemplated by the School Board. Secretary-treasurer, A. Elliot.

East Angus, Que.
Tenders are being received by the secretary-treasurer of the School Board, J. E. Palmer, until 2 p.m. March 15 for the erection of a $25,000 academy school. Plans and specifications with the secretary-treasurer.

East Angus, Que.
P. Boisvert is preparing plans for a $40,000 college.

Halifax, N.S.
Harris & Harris, Keith Building, are preparing sketch plans, and tenders will be called soon for the erection of a $4,000 two-storey frame church for the St. Malthias Church, Windsor Street.

The Military Hospital Commission, Custom House, contemplate converting of exhibition buildings into hospital for returned soldiers. Chairman, Dr. Armstrong. Architect, Department of Works.

Hamilton, Ont.
The City Council, engineer, E. R. Gray, City Hall, are having plans prepared and will call tenders soon for the erection of coal sheds and chutes, to cost $25,000.

London, Ont.
Plans are being prepared by Brigadier G. Miller, Albert Street, Toronto, for an $8,000 two-storey white brick addition to hospital on Riverview Avenue for the Salvation Army.

New Glasgow, N.S.
The Town Council have purchased a site on Stellarton Road, on which they intend to erect a nurses' home. Town Clerk, James Roy.

New Lunnon, Alta.
Plans are drawn and tenders will be called about March 15 by the school district, chairman, R. Goddard, for the erection of a one-storey school.

Ponoka, Alta.
The Department of Public Works, Provincial Government, Parliament Buildings, Edmonton, has appointed R. Blakey, Parliament Buildings, Edmonton, as architect to draw plans for an addition to the asylum.

St. Columbia, East Point, P.E.I.
Chappell & Hunter, DesBrisay Block, Charlottetown, have been appointed architects and are preparing plans for a chapel and parochial hall for the St. Columbia congregation.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **March 14, 1917** **No. 11**

Principal Contents

Page
Editorial ... 215
Architecture in Industrial Buildings ... 217
Slow Burning and Mill Construction ... 219
The Importance of Proper Lighting ... 221
Some Advantages of Reinforced Concrete ... 224
The Industrial Site and Its Relation to the Transportation Problem ... 226
Vibration Problems in Industrial Buildings ... 227
Conditions in Canada's Industrial Centres:
  North Bay ... 228
  Hamilton ... 228
  Chatham ... 229
  Red Deer ... 230
  Regina ... 231
  Windsor ... 232
  Peterboro ... 233
  London ... 233
  New Westminster ... 234
Descriptions and Illustrations of a Few Types:
  Goodyear Rubber Factory ... 235
  A Montreal Box Factory ... 236
  A Western Canada Warehouse ... 237
  A Steel Billet Foundry ... 238
  William Davies Packing Plant ... 240
  Pulp and Paper Mill in Quebec ... 241
  Unusual Coal Handling Plant ... 242
  Bleaching Powder Factory ... 243
  Temporary Munition Plant ... 244
  Grand Trunk Car Shops ... 245
  Lumber a Big Industry ... 246
  A Notable Factory at London ... 247
Mainly Constructional ... 248

Owing to lack of space the third article of the series on the constructional features of the Greater Winnipeg Aqueduct will be held over until the next issue.

Industrial Canada is Finding Herself

THE splendid industrial buildings that have been erected at many points in Canada during the recent past are probably the best indication of the increasingly important position this country is assuming in the commercial world. Yet we believe this position is all too little understood, even by some of our own citizens. On this account we are devoting a large portion of this issue to a description and discussion of Canada's industrial buildings and building problems.

The position of Canada as a manufacturing country is becoming—as a matter of fact, has already become—established. The war in itself has done more, perhaps, to secure this recognition than any other single factor, inasmuch as it has led to the expansion of our industrial conditions to an extent hitherto unprecedented, and has given an opportunity for Canadian manufacturers to show their readiness and ability to supply an empire's need. Not only in manufacture of war products, however, has Canada shown expansion, but in the peaceful industries as well, the factories are, as a general rule operating at capacity rates. The year 1916 has been remarkable inasmuch as it indicated that the slump, so far as our building activities are concerned, has been successfully overtaken. As mentioned in a previous issue of the Contract Record, the value of building permits for the principal cities and towns of Canada during 1916 was 18 per cent. in excess of the value in the preceding year. This bettered condition is attributed largely to the increasing number of factories and other industrial buildings. There have been comparatively few houses or office buildings erected in the last year, and any building expansion that may have been observed is almost entirely accounted for, therefore, by an augmented number of industrial plants.

* * *

Nor will the year 1916 be an isolated example of expansion along industrial lines. There is every indication of even more important developments during the present year, that will make it the greatest in the Dominion's industrial history. True, a great part of the progress will be along munition lines, inasmuch as there are war contracts, valuing hundreds of millions of dollars, awaiting an opportunity of fulfilment by Canada's manufacturers, if only capital is available. Moreover, conditions seem to point out that those industries not directly connected with the production of war material will still grind away steadily and faithfully, doing a volume of business that will, in all likelihood, surpass even that of last year.

It is with a feeling of optimism, then, that we present in this number such articles as will indicate that the past has augured well for and that the future will verify Canada's industrial expansion. So widely is the situation developed that we have been able to indicate only in small part, typical instances of what has been done. The buildings in which our industries are housed are as a guide to the character of the industry itself and the splendid examples of the buildings shown offer ample evidence that the industries are being fostered along the right lines.

* * *

The replies received from a questionnaire sent to the industrial authorities of Canadian cities, representative examples of which are reprinted elsewhere, intimate that throughout the length and breadth of

Canada, with only rare exceptions, remarkable activity in industrial conditions is apparent, evidenced by the erection of new factories, or the extension of existing ones, aggregating in value perhaps $30,000,000. The plants described herein must be taken as merely typical, as it is beyond the scope of possibility to include more than representative cases.

One very important condition that characterizes Canada's industrial situation is the favor with which United States firms look upon the Canadian market and Canadian export possibilities. The outlay for plants built by United States concerns forms a very considerable proportion of the total and within the last two years over fifty companies from across the border have built factories and commenced operations. Hamilton, for example, reports nine new industrial developments by such companies during 1916, while eighteen have located in Windsor, and it was stated very recently at the Montreal Builders' Exchange that over four hundred American firms had made enquiries for factory, shop and warehouse sites, in that city.

These examples, with the more copious matter contained in the news pages, will indicate the impetus that industry in the Dominion has experienced in 1916, an impetus which shows no sign of letting up, but which will stimulate conditions through, perhaps, many a year to come. The possibilities for the immediate future are, to say the least, hopeful. The Dominion's industries have been established on a basis that gives them a prominent place in the world affairs.

Hydrated Lime Consumption

The estimated consumption of hydrated lime in the United States during the year 1916 is shown by Mr. B. F. Laughlin, of the United States Geological Survey, to be 710,000 tons, an increase of 129,000 tons, 22.2 per cent.

While it is only fair to assume that a part of this increase has been brought about by the conditions prevailing in the United States during 1916, at the same time due credit must be given to the work of the Hydrated Lime Bureau during the past two years in developing new tonnage for this commodity. The Hydrated Lime Bureau is an institution organized and maintained by a large number of hydrated lime manufacturers for the purpose of giving to engineers, architects, and contractors complete and accurate information relative to the use of hydrated lime for building purposes. This bureau is just entering upon its third year of life. During the past two years, however, a great deal of development work has been accomplished and a great deal more has been planned. At the recent annual meeting of the Hydrated Lime Bureau an excellent report was made by the working force, showing what has been accomplished during the past year, both in the way of publicity and direct field work. The work of this bureau is gradually spreading to Canadian territory, the bureau receiving each week a rather large number of enquiries from Canadian builders. At the present one Canadian manufacturer of hydrated lime is a member company of the bureau, and is, of course, receiving the benefits to be derived from an organization of this kind. It is to be hoped that all Canadian manufacturers of this important building material will interest themselves in the work of this bureau.

One of the important phases of their work is to give free distribution of bulletins referring to the uses of hydrated lime. One of their recent publications referring to the use of hydrated lime in concrete is entitled "Dependable Concrete." This bulletin will be sent to anyone upon request. The offices of the bureau are located at Pittsburg, Pa.

Toronto Branch C.S.C.E.

The regular monthly meeting of the Toronto Branch of the Canadian Society of Civil Engineers, on Friday, March 9, was addressed by Captain D. M. Mathieson, Canadian Engineers, on "The Engineer in France." In outlining some features of the warfare in France and the part which the engineers take, he particularly emphasized the responsibility that is attached to engineering units. The advice of engineering officers is sought before planning any movement or arrangement of any kind and the troops of the engineering units act as supervisors, using infantry troops as their labor source. Captain Mathieson drew special attention to the fact that the sapper acts as a foreman over working parties, including from 50 to 200 men. The engineering subaltern in many instances is superior to an infantry battalion commanding officer. The work which the engineers in France perform or supervise is stupendous, including as it does the sanitary and water supply arrangements of an area as densely populated as any large city, matters of transport of all kinds, artillery and machine gun emplacements, trench making and maintenance, consolidation of enemy territory, billet arrangements, the parking and supply of all materials besides contributing advice on the tactical manoeuvres of combatant units.

Cutting Down Finishing Costs

Comparative costs, between hand floating and finishing by the belt method, which has been recently advocated and successfully used in Wayne County, Michigan, and other points, as mentioned in the Contract Record of October 4, 1916, p. 954, show a decided reduction in costs and truer finish with the use of the belt method. This method consists of the use of two or three canvas belts slightly longer than the width of the road, which are worked across the road with a crosswise and longitudinal motion, resulting in well compacted, dense concrete, with a true surface.

The comparative costs are set forth in a very interesting record kept on a job in Kenton County, Kentucky, as follows:

By hand float finish, first class job:

Finishers, 12 hours, at $0.50	$ 6.00
Asst. finisher, 12 hours, at $0.35	4.20
Cost per day	$10.20

Average cost per square yard, 1.7 cents.

By belt finish, first class job:

Finishers, 10 hours, at $0.35	$ 3.50
Asst. finisher, 8 hours, at $0.25	2.00
Cost per day	$ 5.50

Average cost per square yard 0.9 cent.

A record in small salaries for engineers appears to have been reached by a Welsh urban district whose surveyor recently tendered his resignation on the grounds that "the salary he received for doing all the work pertaining to the office of surveyor amounted to only four pence a day and there was a good bit of work to be done."

Architecture in Industrial Buildings

Aside From Feature of Added Attractiveness It Has An Advertising Value — Influence on the Employees — Extra Cost is Negligible

Of the many features that must be considered in the design and layout of a factory building no one appears to be more neglected than its architecture. True, the value of appearance is to-day receiving more consideration than heretofore, but for every one factory erected with any semblance of beauty attached to it there are, possibly, still a dozen being built without the least regard at all for attractiveness. This sad state is due to a lack of appreciation of the value of architecture in industrial building design on two different scores. On the one hand the professional architect is himself largely to blame for the deplorable lack of factories of good appearance. The average architect has hitherto regarded a factory as something entirely without the field in which he exercises his ability, and he has failed to appreciate the opportunities that are open to him, feeling, perhaps, that the factory is too prosaic and too much associated with mere money-making to be given over to the thoughts of his artistic mind. On the other hand, the average manufacturer or factory owner is apt to consider architecture an added expense and a poor investment that detracts from his profits and gains for him at best only something good to look upon. His practical mind does not comprehend the advantages that are attached to a factory of good appearance.

Attractiveness a Paying Investment

Conditions are improving, although even yet they are far from what they might be. The architectural profession and the designers are recognizing that in industrial architecture there is opened an unlimited field for artistic ingenuity, and the owners and manufacturers are realizing that the factory with good taste written upon it is not a mere emblem of philanthropy, but an investment that may yield unexpected returns. The experiences of those firms most associated with the incorporation in their plants of artistic designs offer ample testimony that the good-looking factory, even though only tolerably presentable, can and does pay, and pay handsomely.

Ugliness is no more necessary in the factory than in the public monument or the private residence. Many industrial buildings are handsome structures, but in being handsome they do not need to have their factory purpose obliterated. The aim of factory architecture is to keep the factory qualities predominant, but to endow them with an attraction that relieves the purely utilitarian. This is not gained by the inconsistent or haphazard application of ornament on an ugly background, but can be attained only by a considerate treatment of the things that must be present to produce a result that appeals to the sense of good taste and propriety.

The question that at once presents itself is: Is it worth while improving manufacturing buildings architecturally—in other words, does it pay? And the answer to this depends on the practical benefits and advantages that are attached to the quality of attractiveness.

An artistically designed manufacturing building may be considered as producing results in a three-fold direction. First, outsiders carry away an impression that will be good or bad according as the building is attractive or the reverse; or, putting it in another light, there is an advertising value attached to every good-looking industrial building. In the second place, the design and appearance of a factory has an inevitable and, on this account, a most important, effect on the employees who work in it; and, lastly on the owner himself, the value of architecture will have a very potent influence.

Advertising Value of an Impressive Factory

The first and one of the most practical reasons for the existence of the beautiful and attractive factory is that it is a good advertisement. The manufacturer who throws away any source of free advertisement is missing an opportunity for excellent publicity, and for this reason he should use every opportunity to display the merits and attractions of his factory. Nothing is more widely used to create a favorable impression by a prosperous concern than a picture of its plant, provided it is first class, substantial, and attractive. In the average customer's mind there seems to be an inseparable connection between a fine building and first-class product and a bad building and a poor product. Hence, a well-appearing factory may prove of inestimable value in securing trade, and it is to the manufacturer's interest that the impression created by an illustration of his factory, whether appearing in newspaper, catalogue, or advertisement, should be a favorable one. The extra expense, then, that may be occasioned in adding beauty may be regarded as an advertising investment that will yield ample returns by drawing trade.

Attractive Surroundings Influence Employees

In its effect on employees, a factory, well designed and in good taste, has a very influential effect. It is well known and appreciated that an employee's labor and output is largely governed by his mental attitude towards his work. If the maximum output is desired, then the surroundings of the workmen should be such as to improve this mental attitude. By making the building beautiful and the environments attractive a man cannot but be influenced beneficially, and every such stimulation serves to make his work easier. Pride is a very important thing, and it is well known that employees show a great deal of pride in good surroundings and pleasant working conditions, and this in itself has a strong influence on the character of their work, and makes it much easier to pin their allegiance to the owner of such a shop.

Even the owner is not immune from visual influences. As a general rule, he is more susceptible to aesthetic impressions than his employees, and it is only right that he should remove all cheerless and uninspiring surroundings from the place where he spends anywhere from one-third to one-half his life. The average manufacturer spends a great deal of his wealth in providing himself with a beautiful home and attractive furnishings, but he contents himself with the most matter-of-fact office surroundings. The experience of those who have made their factories artistic verifies the contention that not only does the good taste appeal to cusowners and employees, but it produces a most wholesome influence on the owner as well.

Every pleasing factory has still another effect in being of service to the community or city of which it forms a part. It fosters civic pride and helps to bring prosperity to the community.

Factory Architecture Not Costly

The greatest misapprehension that is associated with the incorporation of architectural characteristics in industrial building design is that it is costly. The expenditure for constructing the factory in such a way is believed to be beyond what is justifiable. Nothing is, however, farther from the truth. What is required to add attractiveness is not a great expenditure of money, but the use of a little thought, not in plastering on expensive ornamentation, but in arranging the essential elements of factory design in an artistic manner. There are many of these essential details which, with forethought, may be designed to give interest to the exterior. Lintels, sills, piers, gables, copings, and openings are necessary, and with insignificant expense can be used, by thoughtful and artistic grouping, spacing, and moulding, to make a world of difference between ugliness and beauty. By the use of color and relief structural lines can be emphasized, and by a proper study of proportion the building can be made to appeal to the sense of vision.

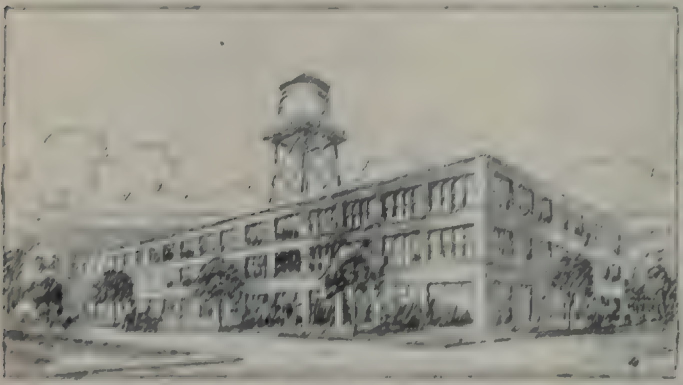
Fig. 1 A purely utilitarian design

The materials used in factory construction lend themselves well to certain types of decorative treatment, at an expense that is trifling compared to the total cost of the building. Concrete, by itself, is perhaps the most difficult with which to attain a pleasing effect, but in combination with other materials the possibilities are far more extensive. With brick or tile exteriors very handsome effects may be attained by architects adept at the production of artistic effects with little to work upon. Some very excellent examples of really pleasing factories depend for their beauty on nothing more than the arrangement of bricks in conventional patterns. Distinctiveness can be quite capably produced by adapting the position and color of brickwork to the evolution of some pleasing design. This mode of architectural treatment, involving as it does nothing in excess of what is required for the plainest building, adds no additional cost so far as materials are concerned.

Color Must Be Properly Handled

Color has a very powerful effect in governing the architecture of an industrial building. It can be made hideous or attractive according to the degree of success with which the color question is handled. The architect in designing a factory has an almost unlimited range of color to choose from at, usually, no greater expense for one than another. Brick, terra cotta, or other burned clay products may be procured in tints as varied as the rainbow, and the architect can select his colors to suit the requirements of the building and the nature of the surroundings. The combination of colors in brick or tile work may also be employed to produce pleasing patterns.

One of the best opportunities for the architect to exercise artistic skill is in the treatment of the sprinkler tank. Nearly all industrial buildings to-day have a sprinkler tank for fire protection, in accordance with insurance demands. In the majority of cases this is left, in all its stark bareness, to injure an otherwise good design. As a rule though, the size of the tank and its height are such as to make it adaptable for a tower that will harmonize with the general lines of the building. To add enclosing walls and roof around such a tank adds comparatively little to the cost, since the supports need little added reinforcement to carry the small extra weight of the enclosing walls, and the walls need not be of a heavy construction. Such a tower can be made to be the dominant feature in the architecture of a factory. In addition to this purely artistic merit, the addition of a tower is important in giving protection against freezing of the water and providing space for the reception of other tanks in connection with the plumbing system, as well as frequently furnishing desirable office space in the shaft below the tank.

Simple Measures Remove Plainness

As an indication of what may be expected and what may be accomplished, the illustrations show a remarkably attractive factory and what may be called a purely utilitarian design for the same building in which the essentials only are present in all bareness and ugliness. The utilitarian design is, unfortunately, more typical of present day practice than the other. By comparison the means by which the attractiveness was produced will be evident. The tower enclosing the otherwise hideous tank is made the most prominent feature of the design, and, in itself, is the centre around which the beauty of this building hinges. Additional good taste is shown in the simple, yet effective, treatment of sills, lintels, and copings. The brick work has been worked

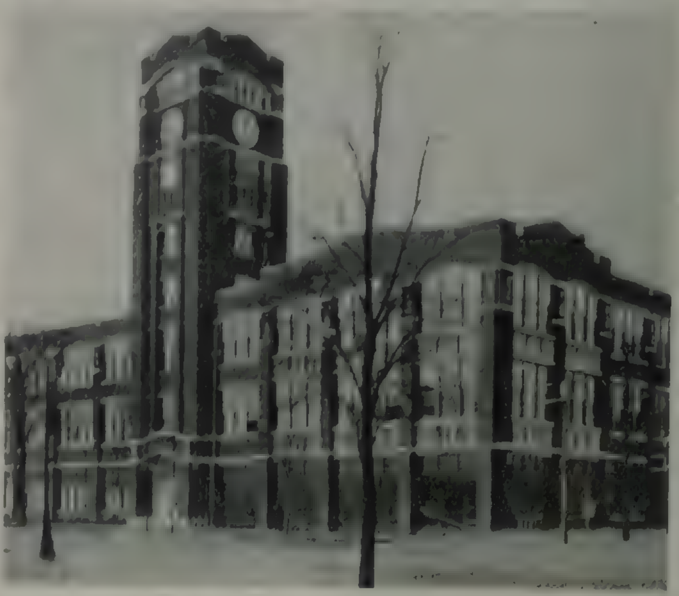
Fig. 2 Same building as Fig. 1, with the marks of "mere commercialism" removed.

out with color bands, unfortunately lost in the process of photographing, and the projecting corner bays and simple gables with arched entrances all serve to remove the plainness.

The remarkable feature of this building is that the degree of beauty which has been attained has been secured at a comparatively little expense. The cost of the factory was $326,000. The contractor estimated the cost according to the utilitarian design as $311,943, so that the total saving which could have been made by adopting the latter design would have been $14,057. In other words, this comparatively small additional expense represented the difference between dismal ugliness and beauty, and saved this building from being an eyesore.

Cost Comparatively Insignificant

Many other buildings furnish proofs that a reasonable degree of good taste can be furnished at a comparative cost of even less than that cited. In the majority of cases the attractive design is dependent almost entirely on the brickwork and stone trim or the materials upon which to work, and the added cost of ornamental terra cotta is so small as to be inconsiderable with the benefits derived.

The foregoing aspects of the subject cover only partially the field open to the industrial architect. Yet external beauty is in itself what most manufacturers have been most backward in providing. There are interior arrangements and conveniences, no less important, that require specifically the attention of the architect, who, through his peculiar training and fitness, is the best agency by which these may be procured. The architecture in the factory, so far as it applies to the beautifying of our industrial buildings, is bound to remedy a striking and deplorable failure in our industrial and commercial conditions. The factory must be raised out of the sordid and purely utilitarian—it must be made a thing of beauty.

Slow Burning and Mill Construction

Cheaper than Concrete—Quality of Timber Important—Mill Type More Liable to Vibration—Offers High Degree of Fire Protection.

By A. R. Denison, C. E.*

THE slow burning system is a most desirable type for the erection of factories, warehouses, etc. The following reasons may be advanced in favor of this form of construction:

1. Economy in cost, in time required for erection, in space occupied by walls, posts, piers, etc.
2. Durability, strength and simplicity of construction.
3. The inexpensive and ready manner with which beams, posts and ceilings allow of the erection of hangers, pulleys, shafting, bracketing, piping and electric wiring.

Fire Protection

The beams, posts, and joists all being of large size and exposed to view, and the floors being of thick, solid body, permit efficient fire protection, as the sprinklers are placed so as to allow the water to come in direct contact with the entire surface. There are no ducts or enclosed spaces in floors or walls, thus preventing fire from climbing unseen throughout the building.

Details of Construction

All footings and foundations should be of concrete. The columns should fit into metal base plates A, (see figure) which are set on top of footings. On top of these columns should be fitted metal caps B. The columns immediately above these should rest on the metal cap direct. The bracket formed by the cap should project and have fillets let into the girders. The girders should rest upon the shelves and in no case upon wood. The girders are thus anchored to the posts by the fillets on the cap.

The floors may be of British Columbia fir, 3 inches thick. All flooring should be grooved and fitted with oak tongue. Then it is usual to cover the 3-inch floor with asbestos paper and form a surface with ⅞-in. maple flooring. Immediately after the 3-inch floor is laid, the joints should be well filled with hot pitch, which will prevent dust accumulating in the joints and afterwards falling through.

The floors must rest upon ledges in walls, which will support the ends and prevent fire from passing between the walls and floors, C. The 3-inch floors must be laid upon and well spiked to heavy joists, the joists being placed at about 8 ft. to 10 ft. centres. The joists will be supported by Duplex hangers, D, let into the girders. These hangers are made in one piece for joists up to a certain size; for larger joists they are made double and must be bolted together through the joists and a second bolt must pass through girder and fasten the hangers together. Heavy wrought iron straps may be placed on top of the joists and well spiked to each so as to form a continuous anchor tie from wall to wall. These should be placed about 10 ft. apart. Where the joists or girders enter the walls metal wall plates, E, must be provided, these plates having fillets so that the timber will fit down on them. The ends of the timber must be cut to splay. This form of anchoring, both as to caps, hangers and wall plates, will allow of timber being relieved in case of burning through, without destroying walls, etc.

Cheaper than Concrete

The cost of this system of construction as compared with reinforced concrete is as 3 to 4. The time required for erection is as 3 to 5 in favor of slow burning construction, the strength in each case being equal.

Should alterations be required in a reinforced concrete building, the cost is very large and a great length of time is required to perform the work. On the other hand, the slow burning system is inexpensive and a very short time is required for the completion of alterations.

If the slow burning system is used and proper attention is given to the matter of enclosing elevators, staircases, etc., with brick or other non-combustible walls, with metal-covered fire doors for all openings into these compartments, and provided the building is properly sprinkled throughout, then the cost of insurance as compared with a reinforced concrete building is 8c per hundred for a slow-burning building and 10c per hundred for reinforced concrete building.

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*Denison & Stephenson, Industrial Architects, Toronto.

As between the slow-burning system and mill construction, I strongly advise the slow-burning system, as the floors are more rigid and steady under machinery.

Mill Construction

This system of construction is similar to slow-burning, with the following exceptions:—

1. There are no joists or hangers:

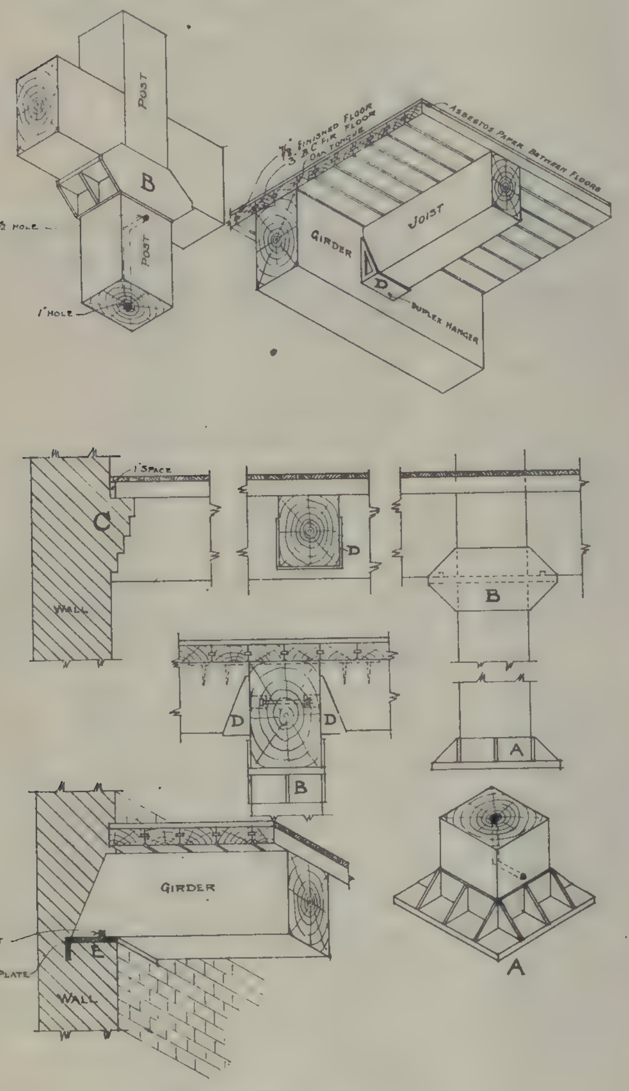

Fig. 1—Details of construction.

2. The floors run from girder to girder and are formed by spiking 2 x 4 in. material together and finished with ⅞-in. maple surface.

3. As there are no joists the walls would require to be anchored to floors, and the floors strapped across the girders. There would be a saving of timbers, but a quarter extra quantity of flooring and extra labor would be required in laying the floor.

Not So Steady with Machinery

This form of construction is very popular and is equal to slow-burning in the support of floor loads, but not so rigid and steady where machinery is used.

In all cases where large timber is used for columns or posts a 1-in. diameter hole should be bored through the entire length with ½-inch cross holes top and bottom to allow drainage and to provide ventilation. There also should be holes in bases and caps to allow drainage. I strongly advise the use of water paint in preference to oil paint, as this will allow evaporation.

Kind and Quality of Timber Important

The most important item to be considered in these systems of construction is the kind and quality of timber, and in my opinion British Columbia fir meets these requirements to the letter. My firm have planned and have had charge of the erection of thirty of these buildings, and in all but three cases British Columbia fir was used with entire satisfaction. In the other three cases Georgia pine was used, and I am sorry to say much of the timber had to be removed through dry-rot setting in.

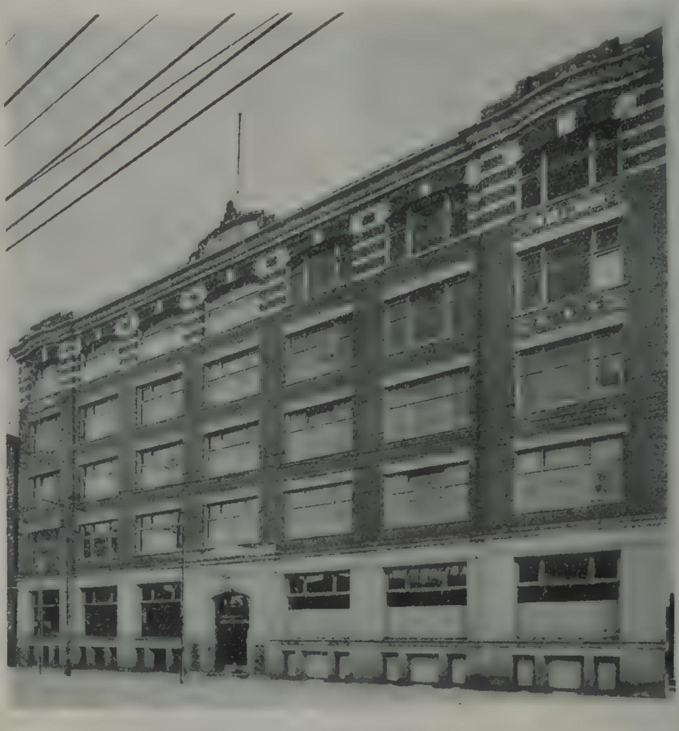

Fig. 2—A good example of slow burning construction.

Some years ago the writer forwarded several sticks of timber of exact size and length to the School of Practical Science so that a test might be made. The tests were made under similar conditions, and the Georgia pine broke at 43,000 lbs., while the British Columbia fir did not show signs of failure till 57,000 lbs. was reached.

The view of the building accompanying this article is one of the buildings lately erected by the writer, and is known as the Purman Building. This I thought a fair example of the slow-burning system of construction, and I am glad to say that the heavy timber used in this building is entirely of British Columbia fir.

The Montreal Council have voted an additional $5,000 for fees for the three independent engineers who are investigating the aqueduct enlargement with a view to reporting on its engineering and economic value.

The Montreal Builders' Exchange will remove to new offices in the Drummond Building in April.

The Importance of Proper Lighting

It Pays—The Employee Does More Work and Better Work, is Happier and More Fit Physically—Cost of Good Light Insignificant Compared with Gains

IN designing an industrial lighting system, there are many items that have to be considered. The first and most important is that adequate illumination must be obtained at a low operating cost. In obtaining such illumination it is necessary that the system be efficient and at the same time it must also be artistic to a certain degree.

Another item to consider is the work to be done under the lighting. This factor decides to a large degree the intensity necessary. With this intensity decided upon and the architecture of the building known, a certain foundation for procedure has been established. In designing any lighting system some form of calculation is necessary in order to obtain proper results. For many small rooms, calculations are made offhand. The experience of the designer tells him at once about what is necessary. In large interiors, complicated with architectural features and artistic considerations, the calculations and designs require engineering ability. For industrial lighting, suitable calculations can be made rapidly and accurately by a number of simple means. These methods are as follows:

Candlepower per square foot,
Watts per square foot, and the
Lumen method.

Let us now, in order, take into consideration the principal types of lighting that are employed when calculations are made. These types are:

Localized lighting,
General lighting,
Localized and general lighting, and
Modified lighting.

Localized Lighting

Localized lighting is one of the systems used, and is most simple. It consists of a single unit of small candlepower, suspended, mounted on a bracket, or used as a portable light in connection with each operation. Its success depends to a large degree upon the workman as it is under his direct control. This is one of the chief objections, as the average workman judges light by its brightness, rather than the useful light obtained from it. As a result of this false idea he will take as bright a light as he can obtain, leave off all reflectors and protection, and then place the light in his direct line of vision. The glare in contrast between the high intensity of the lamp and the dark surroundings in the room, as he glances from his work to adjoining objects, will soon cause eye fatigue. Eye fatigue reduces his ability to see, thereby lowering his efficiency.

The other objections to the localized system of lighting are its high cost, especially in illuminating a large factory where a great many such units will be required. Further, these units are handled very roughly and are thereby subject to a large breakage which will materially increase the maintenance cost. Besides, the drop cords are exposed to wear.

After a short time the installation becomes defective, resulting in short-circuits and failure of the system. The cords are liable to get caught in the various machines, necessitating shut-downs until fixed, and this means not only a loss of time of the laborer but also of time on the other machines nearby.

This type of lighting is particularly adapted to small widely separated areas which are to be well illuminated. There are certain classes of work that cannot be handled in any other manner; such work as in boilers, under cars, boring, or places where a stationary lamp cannot be placed, or where the light must necessarily travel through a long narrow distance with an opening otherwise than toward the ceiling. If correctly equipped with the proper reflectors and suspended in the right relation to the work, this system becomes very efficient when used with discretion. Otherwise, its use is more harmful than beneficial.

General Lighting

General illumination designates a system giving uniform intensity throughout a shop without regard to location of machines or work. It approaches more nearly to the daylight condition than any other system. It consists as a general rule of a lighting unit with the proper reflector suspended above the working plane at a definite height and spaced uniformly. General illumination is more efficient than other means because in its application more efficient and higher candlepower units can be used, thus reducing the number of units necessary and, at the same time, the cost and maintenance. This type of illumination is particularly adapted to large rooms where the entire space should be uniformly lighted.

In laying out such a system, special care should be taken in hanging and spacing the units correctly, as well as in selecting the proper reflector for the distribution that is desired.

General Localized Lighting

As the name implies, this type of installation is a combination of the two types of lighting already discussed. It is particularly adapted to rooms where there are widely separated areas, which need at times a very high intensity, while the general illumination of the room need be of only medium intensity. By using this type of illumination we can save in the current cost, as lamps of much lower wattage can be used to give the necessary general illumination than if it were necessary to produce over the whole floor the high intensity required in the spots.

The same recommendations applied to general illumination and localized illumination can be made for this type also.

Modified Lighting

Modified lighting is to all appearances a form of general lighting. It covers a wide field, from general to localized illumination. In this type of lighting, instead of having uniform intensity over the entire area, the lighting units are hung so that the maximum intensity falls upon the important places where it is needed. Modified lighting is particularly adapted to workshops where the machines are widely spaced and where there is no objection to a low intensity of illumination between them.

Another feature of modified lighting is that units of different sizes can be used. That is, the wattage of the lamps may be specified in accordance with the operation in connection with which each is used.

The same specifications that apply to general illumination will also apply in a great measure to this type of lighting. Modified lighting is used more universally than any other form at the present time.

Intensity

The intensity of illumination depends upon the fineness with which it is necessary to see, the character of the surface to be examined, and whether the workman needs to watch closely and constantly or only at intervals.

Intensity bears a close relation both to the ability to see and the cost of installation. On account of its relation to cost it has been the practice heretofore to use as low an intensity as possible and yet do the work. This policy of using low intensity is changing, due to the campaign and educational work that has been carried on to show the manufacturer the value of efficient fixtures, lamps and good lighting.

Intensity depends upon many variable factors such as the efficiency of the lamp as a light producer, efficiency of the light distributor, efficiency of the walls and ceilings as reflecting surfaces, dimensions of the room, and the height of spacing of lamps. There have been compiled tables of these values, that have been figured out and have proved very satisfactory for different classes of work.

The efficiency of different colors of ceiling and walls as reflecting surfaces has been determined. In using such data it must be remembered that judgment should be exercised and intensities and coefficients of reflection chosen that will suit the given conditions. It is not a settled fact that because a certain intensity is specified in tables for a given working condition, this is the exact and only value that could be used in connection with this condition; it is merely a basis indicating what has been used satisfactorily in the past. By fitting these values to certain requirements, one can readily arrive at some value upon which to base his estimates.

Reflectors

The chief function of any reflecting device is to redirect the light and to shade the source of high intrinsic brilliancy. For industrial lighting the unit should be efficient, while its artistic value is only of secondary consideration, although it should not be overlooked entirely.

The distribution curve of a tungsten lamp indicates the maximum candlepower near the horizontal; it is therefore evident that some device should be used with it to redirect its rays properly. This can be done more easily and better results obtained by a reflector than if the lamp were constructed with a large downward candlepower, and a small horizontal candlepower. If we reflect the maximum amount of light with small absorption, allowing only a small part of the light to escape to the walls and ceilings, we increase the efficiency about 35 per cent., reducing the cost, as a smaller amount of total flux is used to produce a given result. Using a smaller flux reduces the wattage necessary to produce it.

Besides the reduction in cost there is another marked gain in the use of reflectors and that is the protection of the eye. The eye is one of the most important assets of the workman, and the medium through which he is the most readily influenced. A reflector of proper design conceals the intensely brilliant light source and prevents glare, thus reducing the chance for eye fatigue. The better illumination obtained by the use of the proper reflectors and lamps, increases the production, improves the quality of the work, improves the sanitary conditions, increases the efficiency of the plant as a whole and helps materially toward the reduction of accidents.

Reflectors are of various types, depending on the distribution required for each individual industry. Chief of these are: distribution, extensive, angle, intensive, focusing, concentrating, opaque direct, prismatic. Reflectors of some description should be used in every case, but the type best suited can only be definitely determined when all the conditions have been considered.

General Recommendation for Installation

The standards of the National Board of Underwriters, and in Ontario, of the Hydro Electric Inspection Department, pertaining to fire protection should be strictly adhered to. These standards allow two types of installations: the metal conduit, and the open-insulated type with knobs and tubes. The metal conduit installation costs about fifty per cent. more than the insulated knob and tube type installation. The regulations do not allow the open-type wiring to be used in basements, on bricks or stone walls, nor under conditions where deterioration is rapid.

Metal conduit should be used for all new installations because, (1) it is more durable, (2) it is fireproof, (3) the conductors are protected against abrasion and deterioration and (4) it cannot be easily tampered with.

If insulated cord is used for pendants to suspend reflectors, it should be No. 18 packinghouse cord of not less than 15 strands for all lamps of 150-watts or less. For lamps above 150-watts No. 16 or 14 packinghouse cord should be used.

All fuses should be of the enclosed type, and these, with switches and other exposed current carrying parts, should be encased in metal fireproof boxes. In installing lighting systems in departments such as warehouses, vathouses and other departments where it is often desirable to use one lamp at a time or the lamps along one aisle or in one section of the room, it is economical to install circuit snap switches at convenient points. For convenience install one switch to control two groups.

In departments where there is excessive vapor or gas a vapor-proof fixture should be used. This generally consists of an outer glass, which screws into a cap protecting both the lamps and sockets from corrosion, and allowing for convenient cleaning of the globe. The regular porcelain or enamel steel reflector can be used in departments where gases and fumes and moisture exist, provided all defects in the porcelain are covered with acid-proof paint or compound. It is further necessary to protect the brass base of the lamp and socket. This may be accomplished by inserting a flat soft rubber gasket over the lower end of the lamp bulb. This gasket should fit snugly into the neck of the reflector when the lamp is screwed into the socket.

Arguments for Good Lighting

The most important items to be considered are the cost to the purchaser and the savings shown, making the investment worth his while.

When we discuss costs there are several items which are very closely allied. We will take them up, discussing each and endeavoring to show its effect, general and specific, upon the subject. Some of the costs are: Installation, maintenance, operation, accidents and spoilage. Each of these bears an important part, and when considered from the lighting standpoint can be shown to be a vital reason why good illumination should be provided for all the workmen.

In any comparison we need a basis or fundamental unit as a standard. In this case we will use wages of the workmen, as these are one of the most important and readily obtained values. Any industry you visit can readily tell you the wages of its employees and the percentage of these to their production cost.

To the industrial world the goal of endeavor is to increase production, reduce the expense, and at the same time maintain or improve the quality of the product. If this can be done it means increased dividends on the investment. In order to reach this goal all processes of the work must be done with the greatest possible efficiency. The main elements to be considered to reach this high efficiency are material, machinery, labor and light. These four factors are so closely related that the omission of any one would render all the others of no value. What would be the value of either the machine or the laborer without proper light?

In equipping a plant no expense is spared to obtain the most efficient machinery and tools. Thousands of dollars are put into one machine and a high-priced man obtained to run it, but in the majority of cases the lighting is considered of no consequence. In order to get the proper efficiency out of machine and workmen it is necessary to provide illumination of such a value that the eye can see with distinctness and ease; the different operations must also be carried on without stopping, to avoid the loss of many minutes of the workmen's time. Light can be considered merely a tool by means of which the other high-priced tools are used and made more efficient. To get the most efficiency out of the tools, the tools upon which the others are dependent should be efficient, especially as it costs only a small percentage of either the machine or the wages of the workmen.

Assume one 100-watt lamp to each man burning 3½ hours per day, 300 days, cost of lamp upon $150 contract.

Cost of lamp		.54	
Reflector		1.00	
Wiring per outlet		4.00	
		5.54	first cost
6 per cent. interest	.33		
12½ per cent. depreciation	.69		
	$1.02	1.02	
Power at 6 cents		6.30	
Cleaning at 3c per month ...		.36	
Lamp renewals		.54	
		$7.20	total cost to produce

Wages 10 hours, 300 days $1,000 (overhead not included)

$$\frac{7.20}{1000} = 0.72 \text{ per cent.}$$

Further assume an installation in a factory having 30,000 square feet. Use 0.6 watts per square foot and use 200-watt mazda C lamps. This gives 18 kw. connected load.

90—200 outlets	at	3.50	315.00
90—Fixtures	at	1.25	112.50
90—Reflectors	at	1.00	90.00
90—Lamps	at	1.66	149.40
			$666.90 cost to install

Lamps upon $150 contract.

The factory output is worth $250,000 annually, 1/3 made under artificial light, or $83,333.33 1/3. A 5 per cent. gain by good lighting gives $4,166.67 increased business; 20 per cent. profit equals $833.33, which is more than enough to pay for the $666.90 first cost and leaves a margin in favor of the manufacturer. Many central stations give lamp renewals free, thus making the costs lower than shown.

The cost of illumination is only a small consideration for the advantages gained thereby. Statistics prove that the cost of good lighting can be covered by one per cent. of the workmen's wages. Good lighting produces an average increase of 5 per cent. in the output of the industries examined. This compared with the cost of installation will more than offset that cost.

A skilled workman often receives more than 50 to 75 cents an hour, and the one per cent. of this covers the cost of proper light. If we do not give him the correct illumination he must stop to change his machine, go to a nearby window, or make a fine measurement under difficulties. There are many other things which will cause him to lose time, and destroy the efficiency of the work, thereby defeating one of the main principles of efficiency and increasing the overhead cost instead of reducing it; all this because of the lack of proper illumination.

The money side can easily be figured, but it is very difficult to reduce the efforts and the efficiency of the workmen to a monetary basis. Consider, for instance, the workmen as tools or machines. Then for the best results they must work on an efficiency basis, the same as the power-driven units. In order to accomplish this, several factors are to be considered: first, of course, is the wage incentive; following that are the man's interest in his work, contentment, health, happiness, etc.

We all know what effect a dark factory will have upon the workmen. Darkness produces weariness, and in this condition no man can work at the same high efficiency he reaches when rested. Besides weariness, there is, the worst of all, the effect upon the eye of fatigue, strain, etc., which if prolonged will result in permanent defect, thereby not only ruining one of the most valuable assets the workman has but, further, making him a non-efficient unit.

There have been many medical volumes written upon the subject of the eye, its defects and their causes, as well as upon the nervous system as a whole. Many of the diseases are caused by incorrect illumination. The eye is a subject of prime consideration in connection with our health and happiness. Eye fatigue spoils the disposition; as that is one of the conditions given for inefficient work we find here again a reduction in efficiency and a cause for more loss of the workman's time. The first loss was mechanical, the second is physical; both, when reduced to a dollar-and-cents basis, show a large percentage over the cost of the light that would be required to eliminate them.

Some Advantages of Reinforced Concrete

Fireproof in a High Degree—Admits of Rapid Erection—Can Eliminate Vibration—Development of the Flat Slab Type of Construction

By H. Colin Campbell*

CONSIDERABLE thought and study must to-day be given to the planning and erection of new buildings, whether these are to increase accommodation for a growing business or to replace buildings that have become obsolete.

Structures in which an industry is housed are just as much a part of the whole plant as the machinery and other equipment with which the buildings are appointed, yet often little consideration is given to the material of which a building shall be constructed. On the other hand, specialists are employed and with assistance of department heads of the industry, are helped with advice and suggestions relative to the arrangement of rooms, dimensions of floors and general layouts. Materials of construction are too often determined upon after a rather superficial inquiry into first cost and rates of insurance.

Advantages of Concrete for Industrial Buildings

From an industrial point of view, the advantages of a reinforced concrete building are its fire-safeness, sanitary qualities, load-carrying capacity, resistance to vibration, watertightness, speed of construction and permanence. Reinforced concrete has won its prominence as a building material because of the way in which it has withstood many severe tests; among these, exposure to fire.

To-day all-frame buildings are used almost solely for residences and minor structures.

Brick buildings, so-called, have brick walls. The interior is usually of ordinary construction, which means wood floors carried on timber joists, with partitions of lath and plaster on wood studding.

Slow-burning mill buildings have brick walls or walls of other incombustible material with thick, heavy wood floors carried on widely spaced timber joists and girders of large size. Columns are of heavy timbers, wall partitions are of slow-burning type or of incombustible materials. Stair wells and elevator shafts are enclosed. All openings in walls, floors and roof are protected by doors or shutters approved by insurance underwriters.

Reinforced Concrete Buildings are Fireproof

Fireproof buildings may be of steel or reinforced concrete. A steel building has a steel frame of rolled structural members fireproofed with clay tile or with concrete—sometimes a combination of these materials. No steel or iron is left exposed so that the structural stability will be affected in case of fire.

Reinforced concrete buildings are classed by fire underwriters as fireproof. In reinforced concrete structures, steel, which has high strength in tension, is used wherever tension exists, and concrete, which has high strength in compression, is used wherever compression exists in the frame. The proper combination of steel and concrete secures full effectiveness of each material. Concrete offers high resistance to fire and the steel is protected by a covering of concrete which experience has shown ample.

Reinforced concrete buildings have a complete framework of reinforced concrete with reinforced concrete floors, slabs and roof. The walls are usually thin curtain walls carried on spandrel beams so they need be thick enough only to carry their own weight for the height of one storey. Walls, proper, may be of concrete, brick, tile or stone.

Cost is Less in the End

Naturally the first thought which occurs to the manager of an industry when planning a new structure is, "What will it cost"? Cost is, in a great degree, determined by availability of an experienced contractor with a properly organized gang to carry on the work. It is also influenced by location, which affects costs through haulage charges, source of supply of materials, etc.

When first used, reinforced concrete buildings cost considerably more than they do now because engineers and contractors had nowhere near the definite knowledge of design and construction requirements that is available to-day. Only recently an instance was brought to the writer's attention, in which one of the largest construction companies in the country guaranteed to reproduce in reinforced concrete, a factory building estimated for mill construction to cost at least $200,000, and to come within eight per cent. of the cost of mill construction, no matter who made the design nor how long an experience the contractor bidding on mill construction might have had. Even if one has to pay 15 per cent. more for a reinforced concrete building, it will be cheaper than mill construction at the end of ten or twelve years, to say nothing of the numerous advantages which it possesses over any other class of construction.

Flat Slabs Make Easier Fire Fighting

Flat slab construction has some advantages over other methods of using concrete. The beamless ceiling offers no opposition to fighting fire in the stored contents of a building. With no depending beams to block streams of water, the efficiency of fire fighting apparatus is much increased. Not only is the efficiency of a sprinkler system increased for the same reason, but its first cost is reduced, since each head is fully efficient over its rated area. With beam and girder construction there must be one or two sprinkler heads in each panel between beams, regardless of the actual area of floor covered, since the range of each head is absolutely limited by the surrounding beams.

Speedy Erection

With an experienced contractor and ordinarily favorable working conditions, reinforced concrete industrial buildings can be, and in almost innumerable instances have been, erected in a time which compares favorably with any other type of construction. In fact, on some large structures concrete holds the speed record.

The insurance underwriter is interested in having the ratio between income and losses fixed as low as consistent with profits. He must make a profit but if it is found out that this is too great, business men will carry their own insurance by establishing a special sinking fund for that purpose. The insurance man is interested in having more fireproof buildings erected. It reduces his losses. But such buildings cannot be carried as insurance business at a loss, nor is it possible to make wide differences between various classes of buildings.

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*Portland Cement Association.

Fire Due to Exposure and Occupancy

More than ninety per cent. of all fires have been shown to have their origin in occupancy; thirty per cent. of all fires are caused by exposure, in nearly all cases occupancy in the exposing risk being the cause of the fire. When buildings have walls that will not burn and all openings in the walls are protected by approved fire shutters and have, in addition, noncombustible roofs with roof openings protected with approved skylights, thirty per cent. of all fires are guarded against.

Flat Slab Construction Saves in Height

Flat slab construction has an added advantage in that it saves storey height amounting to about one storey in eight without cutting down useful clear head room. This means about ten per cent. saving in the cost of exterior walls, partitions and columns. All vertical equipment is reduced in height or in length of travel. Materials used in erection do not have to be hoisted through so great a distance.

Lighting Possibilities

Every reinforced concrete industrial building properly designed can be a better lighted building than one of any other type of construction. The flat ceiling means more light. The lighting possibilities of a flat slab reinforced concrete building are so far ahead of a mill-constructed building that there is no comparison.

Working Conditions

Every industrial manager is aware of the fact that conditions under which his employees work have a great deal to do with their efficiency. Clean, sanitary rooms with plenty of light, good ventilation and uniform temperature have a money value to the industry. Light and sanitation go hand in hand with concrete construction. Such buildings are free from any possible nesting places for rats and mice, hence losses from these rodents can be eliminated. The permanence and rigidity of concrete make for very low depreciation charges; in fact, it is difficult to show where there will ever be depreciation in concrete buildings other than in those portions which of necessity have been finished with other materials.

Rigidity Eliminates Vibration

Absence of vibration is very important in industries where the buildings are equipped with considerable machinery. A concrete building is more rigid and is therefore more satisfactory for the operation of machinery because there is unquestionably less vibration. Vibration is a mighty big factor in a manufacturing plant, and it is impossible to eliminate this disturbance from machinery placed in mill constructed buildings. If the building vibrates to any extent as the result of machine motion, accuracy of shafting and attachment is disturbed. This has a great effect on the life of machines, shafting and bearings. Furthermore, excessive vibration is dangerous and greatly reduces the life of a mill constructed building. It is exceedingly costly on account of wear and tear on shafting and machines. A paper goods manufacture in Boston, whose plant has both reinforced concrete and slow-burning mill construction buildings, has reported a saving of $5,000 per year in machinery repair and operation charges in favor of the concrete building. This is but one example of the profit that comes from eliminating vibration, and hence directly eliminating depreciation of machinery.

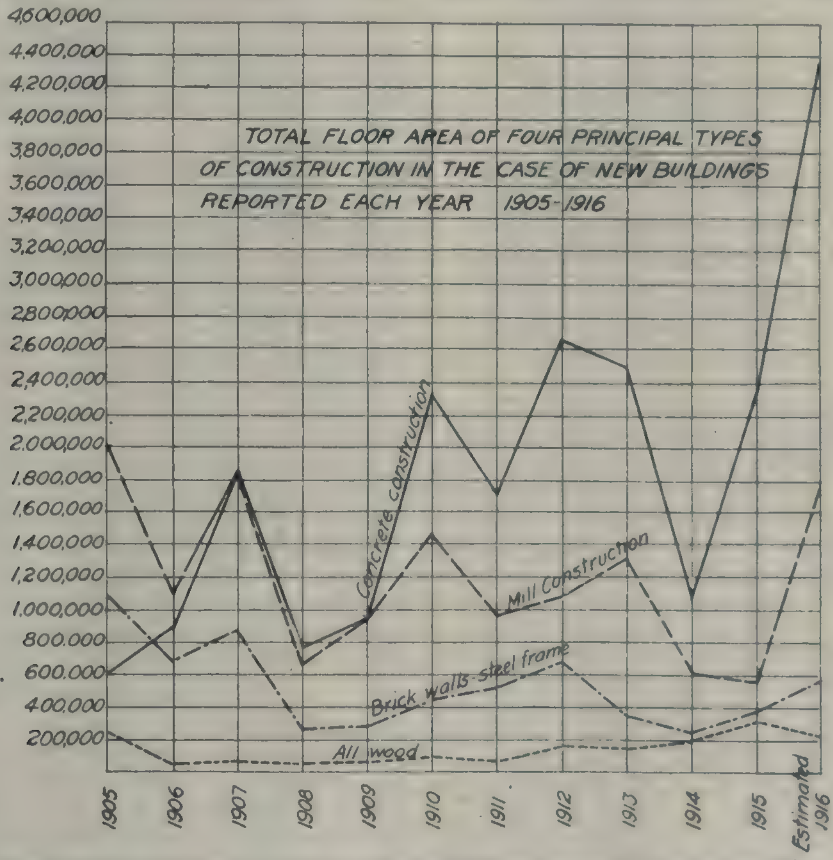


Diagram illustrating the relative use of concrete in industrial buildings as compared with other types of construction.

Concrete Less Subject to Temperature Changes

Concrete buildings can be kept at a comfortable temperature because from the very nature of the construction material the interior is less subject to influences from variations in outside temperatures. The certainty that a fire cannot destroy a building secures the confidence of employees, prevents panics and incidentally adds greatly to the peace of mind of the owner.

Sometimes objections are raised against working on concrete floors. Many reinforced concrete buildings are provided with maple wearing surfaces to the concrete floors to obviate this objection, but it is worth while to call attention to the fact that there are many buildings with hundreds of acres of floor space devoted to factory purposes and employing thousands of skilled artisans where it has not been found necessary to provide any other working surface for the employees than the concrete floor. One notable example of this is the building of the Ford Motor Company, which is now using, in its modern buildings, concrete floors rather than wood flooring laid over the concrete. This is true of practically all the automobile factories throughout the United States. A decided advantage of concrete floors is that they are watertight, and if fire-fighting must be done on one floor, water cannot leak through them, and on to contents of a floor below, thus causing additional damage.

Concrete Buildings Increase in Strength

In making cost comparisons, a common fallacy must be avoided. When an owner builds a mill constructed building, he very frequently equips the building throughout with the cheapest of fittings and appliances. On the other hand, the owner whose business judgment directs him to build a fireproof structure usually selects high grade fittings and equipment and in other ways adds to the actual cost of the structure by comparison with mill construction because of a desire to make all appointments in keeping with the better class of building. A mill constructed building will require repairs and maintenance which in a period of twenty years will almost, if not actually, equal the original cost of the building. It has the disadvantage of decreasing in strength and carrying capacity, no matter how consistent may be the efforts to keep it well maintained, while reinforced concrete buildings increase in strength with age and perpetually remain free from the necessity of maintenance expenditures.

Vibration Problems in Industrial Buildings

Their Causes, Effects and Suggested Remedies—Decreases Efficiency of Workers and Machines

ONE of the least studied of the many industrial problems is the effect of vibration in factory buildings. In the technical publications little has been published that covers in any comprehensive manner the vibrationary problems in industrial establishments, but what little has been done, however, in studying the subject has indicated the importance that is attached to the elimination of disturbing vibrationary influences. Factory buildings, on account of the machines operating in them, are peculiarly susceptible to vibration, which, by acting on the nervous susceptibilities of the workers, causes reduced efficiency, poorer work, and slower speed.

Two sources of vibration may be apparent—internal or external. Vibration from internal sources results from the motions of machines or equipment, which may be transmitted to the floor and walls of the structure, while externally caused vibration is produced from sources entirely outside the building. The study of vibration and its effects and how it may be eliminated or avoided is a complex problem at best, inasmuch as it is difficult to assign specific causes to the effects produced or to analyze the intricate influences concerned. Conditions in factories vary to such a degree and the personal factor is so inconstant that there is a great diversity of opinion as to just where vibration begins to prove harmful. The best that can be done, therefore, is to cover only some of the more general factors associated with the subject.

Vibration Affects Quality of Work

Vibration of a building may have a very serious effect on workmen. If it is at all severe, the efficiency of their labor may be very materially reduced and the output will be smaller, while employees will reach a state of fatigue sooner. By taking measures to counteract the vibrationary effects it has been found that greater human efficiency is possible with higher speed of workmanship and a better quality of work. Closely coupled with the efficiency of the worker is that of the machine, which is affected by vibration in one way or another. The effect on machinery is manifested in decreased output. The experiences of factory owners who have installed old equipment in new and stable buildings indicates that the output of these machines has greatly increased, due entirely to the elimination of vibration.

Factory building vibration is often responsible for waste of power and difficulties with line shafting. The vibration, in such a case, results in a mis-alignment, which makes it impossible to keep shafting true, with the result that added friction produces a loss of power. Trouble is often occasioned, further, with crystallization of machine parts on account of the vibrationary effects, for, where the machines are not cushioned, severe vibration may result in crystallization of the metal parts and end in their breakage.

Coincidence of Frequencies

Every part of a building has a natural pitch, and, when set in motion, will vibrate at a periodic number of oscillations. The entire building, as well as its component members, conforms to this characteristic. The most harmful condition takes place when the frequency of the source of vibration coincides with the frequency of the building. When these are coincident, the action is aggravated, and may produce serious results. The effect of coincidence between the natural frequency of vibration of a floor and that of the source of disturbance is well illustrated by an experience contained in the report of the Aberthaw Construction Company, who have been conducting comprehensive investigations on the effect of vibration in structures. The case in point had to do with the testing of a small engine upon a floor of timber construction. At a speed of about 550 revolutions per minute the intensity of the floor vibration was so great that it was impossible to work in the drafting-room, located on the same floor more than 100 feet away, but this effect entirely disappeared when the speed was either increased or decreased by about 50 r.p.m. If the cause of vibration be intermittent and of a different frequency, the result will be a breaking-up of vibrations.

Vibration transmitted from sources outside the building are the most difficult to trace and the most difficult to overcome. The effect of passing trains is very common, and the transmission is due either to soil and rock vibrations or to atmospheric vibrations. In regard to vibration from external sources, Mr. Maurice Deutsch, C.E., is quoted in the report referred to as follows:

"Vibrations have of late been absorbing the attention of not only scientists, but of the general public, in large cities. Since the introduction of skyscrapers, towering far above adjoining buildings, of large printing plants and power-houses, diversified complaints of vibration are frequently heard. The operation of heavy bed presses and reciprocating engines leave in their path a tremor to which many adjoining buildings are so naturally attuned that the vibrations are often not only annoying but dangerous, both to the building in which the machinery may be operating and to adjoining structures.

Rigidity Avoids Vibration

"In concrete steel monolithic structures, when properly designed, the entire mass acts as a unit to absorb vibrations, the main tendency being to set up an oscillatory motion of the entire structure; but this can generally be avoided if proper foundations are constructed, and if such precautions are taken in the location, arrangement, and operations of the moving machinery as have been found from experience would materially reduce the possible transmission of vibrations."

Absence of vibration in industrial buildings can be attained by giving due respect to the rigidity of the structure, to foresight in the placing of certain machines on solid foundations, to the proper cushioning of others, and to such arrangement of duplicate machines operating at the same speed as to avoid cumulative effect. Old buildings are usually more susceptible to vibrationary influences than more modern buildings, inasmuch as they are often unsuited to present-day requirements, and, moreover, many conditions which would receive immediate attention in up-to-date factories are often allowed to continue in old buildings.

The Industrial Site and Its Relation to the Transportation Problem

By F. W. Cowie, B.A.Sc., M. Inst. C.E.

INDUSTRIAL corporations have achieved success beyond expectations in Canada during the past several years. "System" resulted in general managers who are now presidents. "Organization" combined system with concentration, resulting in lower overhead charges, less direct competition and less duplication. This was the foundation keynote of the success of some of our largest and most successful corporations, whose presidents are now millionaires.

"Efficiency" is now the word. There is the example of German efficiency which almost brought the whole world to its feet. The efficiency expert cuts out a movement and by multiplying by a million, saves an amount laid down to three places of decimals. The success of the past will be forgotten by the results of the future, due to efficiency methods supplied to 50,000,000 men and 100,000,000 machines.

Of later date and with even greater expectations is the present-day cry, "The Application of Science to Industry." The utilization of products formerly wasted; the scientific investigation into new products by new methods; the day of the scientific investigation is at hand . . . . that is if he "keeps his feet on the ground."

"Save a dollar," excellent!

"Create a dollar's worth," even better!

But after all, the value of a dollar must not be either forgotten or overlooked.

The great and successful corporations have system, they have organization, they have efficiency experts and they have their scientific laboratories.

It is however absurd to think of how much the transportation factor is overlooked.

"I own a vacant lot, I will build there."

"This land is cheap, it will save capital."

"That is an excellent opportunity offers to purchase a factory all complete, it will save trouble."

"I want a site within motor distance of my home."

"For national reasons we are obliged to build and operate in Canada, but we only build to prevent possible strong competition, and we choose a site as near as possible to the parent concern."

Why is not the real, vital, economic question of transportation taken into first consideration, as, after all, next to good and ready labor, it is the key to success.

Where will the shipments come from? How will they come? What will be the cost? How about despatch? How about terminal charges?

How can delivery freights be reduced to a minimum by locating at a centre where a large proportion of the output will be consumed or taken delivery of locally? Where can cars always be obtained? How much will be the terminal charges for roads not connecting with plant sidings? How can plant sidings be simplified and shunting reduced to a minimum?

We hear of one firm located most advantageously on a canal site, but business is disorganized in winter, when navigation is closed.

Another is given splendid terms by a railway company, but it is difficult, often impossible, to get cars. This successful company has urgent business at good profits, but despatch being impossible, it is lost. An enterprise has the last call in some up-to-date production, but as it is located on a local railway, it costs 4 cents per 100 lbs. over the local or city rate for terminal charges and switching. A twenty-million-dollar enterprise is located where not one ton of its tremendout tonnage output will ever be consumed locally, and has to compete with a firm supplying half its output to the local firms at practically no delivery costs.

It is most refreshing to hear that in many large centres of population and industrial activity the question of terminals and radial or marginal railways is at last becoming a governing factor of success or failure. The more congested the district the more it will cost, and cost what it may, it must be incurred or the community will be left behind.

Ten cars per day in and ten out is an ordinary industrial turnover. At 2c per 100 lbs., for one extra switching rate, and the average is generally more, there is a fixed charge against the business of $200 per day, or $60,000 per annum.

Despatch in delivery and the question of cars is of almost equal economic importance.

Capitalists would do well to see that this important matter is carefully considered before they subscribe financially to new industrial undertakings.

Conditions in Canada's Industrial Centres

Are Reported as Being Satisfactory—1916 Returns Show that the "Slump" Has Been Overtaken—Brief Reports from Civic Officials at Various Points Typical of a General Confidence in the Future

NORTH BAY

NORTH BAY, an important railway town, with a population of 10,000, is located at the gateway of New Ontario, the development of which will be gauged by the growth of this town, as the four railroads—namely, C.P.R., G.T.R., C.N.O.R., and T. and N.O.R.—which have terminals at this point, diverge through the mineral area and the great clay belt of the North Country, where lies, almost dormant, untold strength in the roaring, boiling waterfals, waiting to be harnessed and turned into electric energy.

The industrial conditions of the town are brightening rapidly in the manufacture of toys, lumber, wooden construction materials, and macaroni, and in the smelting of ore. A large, up-to-date building will be erected this year to accommodate the increasing business in the manufacture of toys. The town is favorably situated for a chemical plant, a tannery and woodenware industries, as great quantities of hardwood, hemlock, pine, and other timber are within a short distance. The railroads have excellent facilities for the handling of freight and passenger traffic, the housing, repairing, and construction of locomotives, and extensive repairs or construction of freight cars.

The C.P.R. engine-house is of the circular type, comprising 23 stalls, the exit from which is over a 70-ft. turntable. Connected to this engine-house, by complete machine and blacksmith shops, is a modern rectangular 10-pit locomotive erecting shop, access to which is had over an electrically operated transfer table. Close by is located the car repair yard, with a six-track enclosed car repair and erecting shop, off which upholstering, air equipment, carpenter, and blacksmith shops open. These car repair tracks proper have a capacity of 156 cars.

Special provisions by the railroads for the benefit of industries and local wholesale and other dealers requiring trackage facilities have been provided in the shape of industrial tracks, with sites adjoining, which can be acquired for business purposes.

By Mr. H. J. McAuslan, Town Engineer.

HAMILTON

SINCE the beginning of 1915 fifteen new factories have located in Hamilton, nine of these factories being of United States parentage, which is imposing evidence of the attractive power of the Canadian market and of Canadian export possibilities. The largest of these industrial undertakings was that of the Proctor & Gamble Company, the proprietors of ivory soap and sundry other soap and cotton seed oil products, who erected an immense plant here.

The Dominion Sheet Metal Company erected a new factory for the manufacture of galvanized sheets. Canadian Horse Shoe Company, a branch of the United States Horse Shoe Company, of Erie, Pa., built a facfory for the manufacture of horseshoes and toe caulks. Canadian Cartridge Company built a new factory for the manufacture of cartridge cases. This plant is working a day and night shift. Franklin Steel Works, of Joliett, Ill., leased a factory for the manufacture of toe-caulks. T. Eaton Company built a big four-storey factory for a knitting mill. W. T. Rawleigh Company, of Freeport, Ill., will erect a factory shortly for the manufacture of household medicines,

By Mr. H. M. Marsh, Commissioner of Industries.

Proctor & Gamble Company's soap factory · one of Hamilton's many fine factories.

extracts, toilet articles, and stock and poultry preparations.

The Hamilton Steel Wheel Company have erected a new factory for the manufacture of steel car wheels. Stanley Steel Company have built a factory for the manufacture of cold rolled sheet steel. The Carbon and Alloy Steels, Ltd., will erect furnaces and a foundry plant this year for making steel castings, ingots, and similar products by the Moffat electric process. The Perkins Glue Company, of Lansdale, Pa.; Ontario Yarn Company, of Markham; Watkins Medical Company, Winona, Minn.; Turner, Day & Woolworth Company, of Louisville, Ky., and the Desmond-Stephen Company, of Urbana, Ohio, have also located branch factories here within the last two years.

Proctor & Gamble's factory, Hamilton, Ont.

The Mercury Mills Company are completing a new large hosiery mill and spinning mill. The Chipman-Holton Company are building a new spinning mill.

Nearly every one of the big concerns are prospering and largely increasing their plants. In fact, during 1916, 71 new factories and additions were erected here, the building permits for these totalling $994,446.

CHATHAM

CHATHAM can boast of forty-three flourishing industries, with capitalization ranging anywhere from two million dollars, down. Chief among these industries is the Hayes Wheel Works, who manufacture all kinds of automobile wheels, hubs and rims; the Dowsley Spring & Axle Company, the largest manufacturers of automobile springs used in Canada, also carriage axles and springs; the Pad & Textile Company, who make all manner of felt goods; the International Harvester Company, who manufacture farmers' wagons; the Dominion Sugar Company, who have the largest sugar plant on the North American continent; and the Gray-Dort Company, one of the largest producers of automobiles in Canada.

Chatham is also well supplied with financial institutions, six of the best banks being represented here.

The railroad facilities are exceptional, in that Chatham is supplied by five railroads—three of them American lines, and two Canadian. The great advantages in having the American lines are that, in shipping west you can procure tariffs via the United States, which gives you a much better opportunity to obtain cars for shipment, than if you had to ship directly over Canadian lines, which are frequently short of equipment.

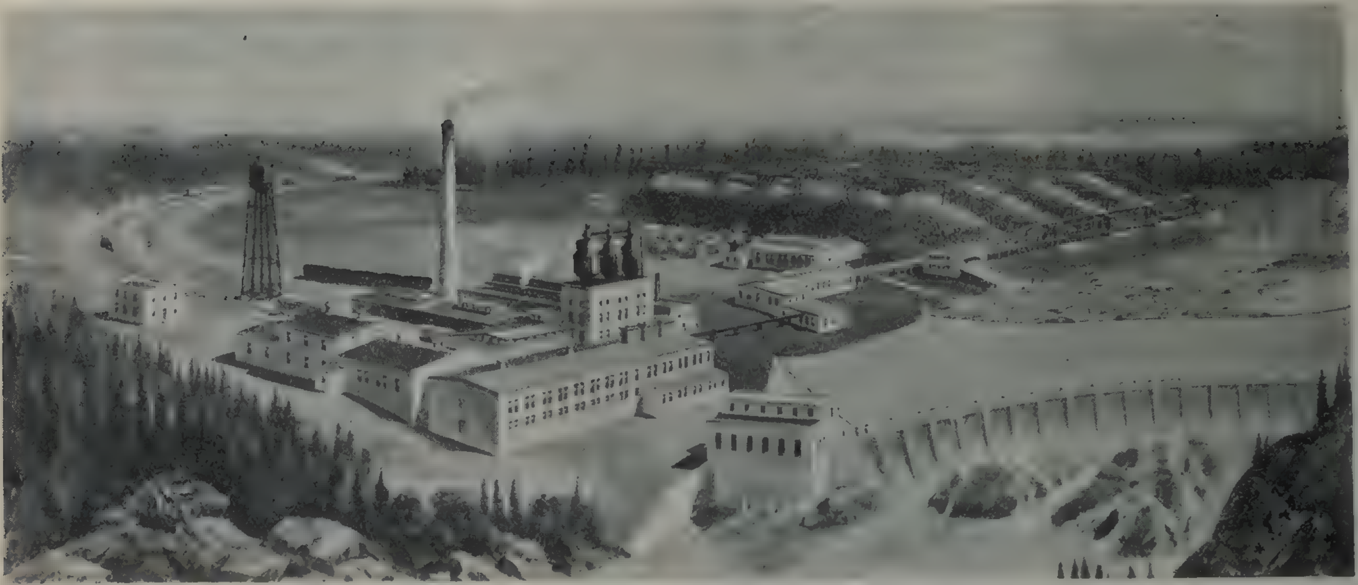
Chatham also has direct waterway connection with the Great Lakes, which gives access for shipments touching at all points on the lakes. There is also a regular boat service maintained between Chatham and Detroit.

The labor conditions here have shown that the employer and employees work to their mutual advantage, in that Chatham can boast of never having had a large strike.

The manufacturers are exceedingly fortunate in that Chatham is supplied by the well-known Tilbury Gas Fields, with natural gas, which the manufacturers have the privilege of using for power, at the rate of

By Mayor J. G. Kerr.

The Dominion Sugar Factory, Chatham, Ont. Largest sugar plant on North American continent.



Mattagami Pulp and Paper Plant Typical of one of Canada's biggest industries.

12 cents per thousand. It also has Hydro electricity, which supplies power at a nominal rate to the manufacturers.

The city controls the waterworks and there is a generous supply of good, clean water, at low rates.

Should a manufacturer desire to use coal, Chatham is the distributing point for all coal used on the two Canadian railroads before mentioned—this coal coming across regularly by boat, to a point twelve miles south of Chatham.

Chatham is served by four express companies, which gives excellent service, and creates good competition.

The residential districts in Chatham are well adapted to the conditions necessary for the laboring man, in that they are not expensive to rent, and are within easy access of the various manufacturing plants.

The city has two parks, which are nicely located and gives an excellent recreation ground in which to enjoy sports, etc., after working hours.

In conclusion, Chatham is surrounded by a very fertile district, which has mixed farming; and also has an exceptionally fine fruit district in the southern portion of the counties. Being surrounded with fertile land, it naturally results that there are an exceptionally fine class of merchants in the city, at whose places goods can be bought at prices that compare favorably with any of the larger stores in the Dominion.

The city enjoys an excellent climate, in that it is located in the most southern portion of the Dominion of Canada. It has been favored with an energetic Council and Board of Trade, who, in the past two years have been successful in procuring five large industries.

Less than a year ago the Portland Cement Association issued a booklet on concrete swimming pools and through its cement products bureau has done very extensive promotion, both of municipal and private pools. As a result we hear of many pools in cities, from the Atlantic to the Pacific, planned for the coming year. The swimming pool situation is being handled in many cases as are paving propositions, municipal bond issues being arranged to provide the necessary funds for undertaking the construction.

RED DEER

RED DEER is the centre of the mixed farming district of Alberta, and the principal industries of this district are butter and cheese making. There are two creameries and cheese factories in Red Deer, both running to capacity and increasing their output. Throughout the district there are many smaller plants, all doing well. A large quantity of cream is shipped to Calgary and Edmonton, besides what is manufactured here. The dairymen around here are making money and any man with a little capital and willing to work can do well at dairying.

The Great West Lumber Company has a large sawmill here and ran it part of the summer, as demand for lumber was good last year. The two brick plants here did not operate last year, the demand for brick not being good.

Labor was scarce and any able-bodied man could get work; labor will be scarcer this year.

Building was quiet in the city, but many farmers built new houses, barns, etc., and carpenters had plenty of work. Campbell, Wilson & Horne, wholesale grocers, built a new warehouse last summer. The Canadian Northern Railway Company is just completing a bridge across the Red Deer River and we expect connection with this line this summer, as they have the grade completed from the Brazeau line to Red Deer. There is a good demand for modern houses in Red Deer; at present there are no modern houses vacant and more will have to be built. There is little demand for houses without modern conveniences.

Prospects for 1917 are that there will be considerably more building done than in 1915 or 1916. The Provincial Government is planning to build large additions to the Alberta Ladies' College, which they purchased last year for an institution for defective children of the four western provinces. These additions will probably cost over $100,000. The two wholesale grocery firms located here are doing well and increasing their business steadily.

Red Deer being the centre of the dairying industry of Alberta there is a splendid opening here for a con-

By Mr. A. T. Stephenson, Secretary-Treasurer.

densed milk industry, as milk can be obtained here in quantity, and cheaper than any other place in Alberta. We look, in the near future, for such an industry to be started here. Prospects are good for a steady, healthy growth in the future.

REGINA

REGINA, the capital of the Province of Saskatchewan, is more and more becoming recognized as the commercial and distributing centre in Central Western Canada.

A review of business in Regina for the past year, from an industrial standpoint, reveals a very satisfactory condition. Those engaged in every line of business are able to show a large increase over the preceding year, notwithstanding the fact that a very heavy drain upon the manhood in Western Canada has taken place during the past few years, which removed from the community a very substantial purchasing power. It did not, however, remove the activity in which these men were engaged, as their places have been taken, and very creditably filled, by women. This is very noticeable when one enters the banks, wholesale houses, retail, mail order, and other establishments.

The total turnover during the year 1916 is very very much greater than that of 1915. This fact is demonstrated by the customs returns of the port of Regina probably better than in any other way. If goods are not required they are not usually imported. Customs returns for the port of Regina during 1915 were $653,915.75, and for 1916, $1,505,219.20. The bank clearings for 1915 amounted to $87,122,611.08, and for 1916 they were $124,349,589.81, putting Regina in fourth place among the cities of the West, from Fort William to Victoria inclusive, Winnipeg, Vancouver, and Calgary only showing a larger volume.

The Robert Simpson mail order warehouse, Regina—Canada's department stores are world renowned.

Indications point to an active building programme in Regina during the coming year, as there are quite a number of manufacturers, wholesale houses, jobbers, and others intimating their intention to locate a branch of their business in this city, and there are not many warehouses available at the present time. The same can be said in connection with the retail houses. A number of prospective merchants are anxious to locate in Regina, but they are unable, at the present time, to find suitable available quarters. This will have a tendency to create some activity in the building line during the coming summer.

Special reference should be made to two industries that have become established in the city during the last year and a half. The Imperial Oil Refinery have purchased fifty acres of land and established a refinery, which is now in full operation, costing one and a half million dollars. Reference should also be made to the Robert Simpson Western, Ltd., mail order house. The Robert Simpson Western, Ltd., a little over a year ago purchased property from the city and erected thereon a mail order house, costing $350,000; they employ in the neighborhood of 1,000 people, and are doing an enormous business. While we are unable to quote the

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By Mr. L. T. McDonald, City Commissioner.

Frederick Stearns & Company's factory—Windsor added 18 American branches in 1916.

figures involved in their enormous turnover, we may say that they have admitted that their business is 200 per cent. greater than they had anticipated for the first year, and they are already preparing plans to enlarge their premises.

WINDSOR

THE industrial life of Windsor for the past year has been very active. All manufacturers have been running their plants to full capacity, on their usual lines of manufacture, and not engaged in munitions. We have not had any vacant factory space.

Indications are that the present year will far eclipse any previous year in the industrial life of Windsor. 1916 building figures far exceeded any previous year, and yet there is not an empty house in the city.

Eighteen branches of American factories have located since the beginning of 1916, and many more are negotiating for space and new plants. The future prospects look very encouraging. The Maxwell Motor Company have purchased four acres of land and are expected to build a plant suitable to take care of present and immediate future business. The Merchants Bank have completed a fine office building on the corner of Ouellette and Chatham Streets. The Huron and Erie Loan Company have purchased one of the best business corners on corner of Ouellette and Pitt Streets, and will commence the erection of a modern office building. The Peoples Loan and Savings Company have opened up offices on Sandwich Street. Work on the new Steel City of Ojibway is progressing as quickly as conditions will permit. The foundation work of a big city is being carefully planned and worked out.

There is reproduced in this issue a photograph of the Kelsey Wheel Company which has in the past few years developed into a complete and modern plant. This plant manufactures bodies and wheels for automobiles. They are negotiating to enlarge the plant by one-half. Also the photograph of the Frederick Stearns Company. This prosperous concern have added the new right half in the past few years, and added a new department, that of confectionery and fancy soaps. This addition has been a complete success. They have purchased the entire block back of this plant for extension purposes.

By Mr. T. C. Ray, Secretary Windsor Industrial Bureau.

The Kelsey Wheel Company—Another of the Windsor, Ontario, activities.

PETERBORO

INDUSTRIAL conditions in Peterboro have been good. During the past year the manufacturers have been busy; there has been steady employment, and, while at times the demand for skilled mechanics in some lines has somewhat exceeded the supply, there has been, as a rule, no trouble in securing labor, and towards the end of the year the conditions in this respect became even better.

Among the new industries of 1916 was that of the Peterboro Metal Products Company. This company leased, with an option to purchase, the premises formerly occupied as a cordage factory, equipped it with machinery, and the industry has grown steadily until the company is employing about 400 hands. Another new factory established during the year was that of the F. C. Paul Company, manufacturers of children's dresses. Other recently established industries, including those of the DeLaval Company, Henry Hope & Sons and the Vermont Marble Company, have been doing well.

Several industries were enlarged during the year. The Bonner-Worth Company, manufacturers of yarns, erected several additions, 95 ft. x 66 ft., two storeys; 37 ft. x 36 ft., two storeys; 90 ft. x 36 ft., two storeys, and 45 ft. x 32 ft. and 44 ft. x 44 ft., one storey. The Auburn Woolen Company added an extension 80 ft. x 44 ft. The Quaker Oats Company raised their warehouse, 280 ft. x 60 ft., two storeys, while other factories added to their accommodation.

A new church and extensive alterations to business blocks, together with the erection of houses, make up a fairly busy year in building.

Business generally, with plentiful employment and high wages and the high prices which farmers received for their produce, was prosperous during the year.

For the immediate future the prospects are promising. The Trent Waterway will be opened to Lake Ontario, and this is expected to add to the prosperity of the city.

The Bonner-Worth Company have secured a site for a new industry, in which they will manufacture other lines of yarn, and will erect a large building in the spring, to equip which the machinery has been on order for some months.

The rebuilding of the extensive Quaker Oats plant, which was destroyed by fire in December, will add to the building activity, and new industries being established are those of the Peterboro Milk Products, Ltd., and another fur factory. Other industries in prospect, together with the growing importance of those established, make the outlook very promising.

By Mr. S. A. Armstrong, City Clerk.

LONDON

AT the beginning of 1917 the industrial situation at London shows unmistakeable signs of more than usual activity. Towards the end of last year, under the auspices of the Board of Trade and members of the City Council, a charter was granted to the London Industrial Association, Limited. This is a public-spirited body, formed for the purpose of reducing the initial cost of establishment of desirable industries, and a number of the more prominent businessmen of the city appear on the list of the shareholders and officers.

Under the direction of this association, a deal was completed in the early spring with Beatty Brothers, of Fergus, for the erection of a foundry, costing approximately $28,000 to $30,000, in Chelsea Green, a London suburb. Here the owners of the land were enterprising enough to place eleven acres at the disposal of the association, which will be conveyed to Beatty Brothers, in view of developments being made at the present time and in the future. Beatty Brothers have, in addition to their extensive plant at Fergus, a factory employing some 100 men at London, and the plans of the company include the uniting of the plants on one spot and very considerable development in new buildings in the early future. It is likely that before long they will employ between 300 and 400 in London.

Another industry recently started at Chelsea Green is the London Smelting and Refining Company, under the direction of Mr. George Trudell. This company purchased the old power-house of the London and Lake Erie Railway Company, and have been some months in the business, and employ quite a number of hands smelting and refining metals, which are used for munitions parts.

The McClary Manufacturing Company, London's leading industry and probably the largest manufacturers of stoves in the British Empire, have purchased land in the vicinity of their factory, and have erected a three-storey addition for the japanned work department. The council has recently given them permission to lay pipes for natural gas, which will mean development of their enamelling plant at this point.

The Ford Motor Company, it is reported, contemplate extensive additions to their London assembling plant which will more than double their present floor space and considerably increase their output of cars.

Penman's Limited, of Paris, Ont., have leased premises on a down-town thoroughfare and will establish a knitting branch. It is probable that the labor situation here will justify them in still larger operations at London in the early future.

The Canadian branch of the H. S. Hall Company, of Jersey City, has been established at London. The Hall Company are manufacturers of ladies' fabric and chamoisette gloves. At present their operations are confined to the sewing and finishing, but it is their intention to build a plant at London, where they will weave the fabric used in the manufacture of gloves.

The recent purchase by the Middlesex Mills, Limited, a London company, of a large building in the east end of London has made possible considerable development in this firm's textile plant, and also the addition of a dyeing plant, which will be in operation in the early part of April. This addition to the industries of Ontario will be welcomed by a large number of manufacturers and dealers in textile goods, as there has been considerable difficulty in securing work of this kind. The manager of the dyeing plant is a man of acknowledged superiority in this business, who has already a very considerable reputation as a dyer in Canada. So far the Middlesex Mills have confined their operations to the weaving of cotton towelling and fabrics, but new machinery is being installed, which will increase their range of manufactures very considerably.

A large number of plants in London are at present

By Mr. Gordon Philip, Secretary London Board of Trade.

engaged in the manufacture of munitions, and new concerns are reported frequently.

At present the labor situation is particularly good, and London has always had a large supply of capable machinists.

The Quaker Oats Company, of Chicago, recently purchased the local branch of the Canadian Cereal and Milling Company, and have started operations therein. These are considered to be largely of an experimental character, with a view to extending operations from this centre very considerably if conditions are found to be as they anticipate. Their decision in this connection may be helped by the fact that the city council has asked for authority from the legislature to erect a grain elevator at Port Stanley—London's harbor on Lake Erie—costing approximately $100,000. This elevator will supply quite a large number of mills in London, St. Thomas, and vicinity, which are at present supplied from Goderich, and, it is anticipated, will make Port Stanley a grain receiving centre of some importance.

The electrification of the London and Port Stanley Railway promises to play an important part in the city's industrial expansion, as the advantages of this aid to the economic assembling of raw materials and fuel and transportation of manufactured goods becomes more generally known. The road provides competitive water route, ensuring equitable freight rates for shippers over the steam lines, and is directly connected with the Grand Trunk, C.P.R., Michigan Central, Pere Marquette, and Wabash and branch radial lines. It is claimed—not without reason—that in assembling of products of iron and steel and coal London is situated to better economic advantage than any other Canadian city of equal or greater size. As centre for distribution throughout the Dominion it is well situated for both lake and rail transportation, and there is also a home market of upwards of a million people in the Western Ontario peninsula.

These circumstances and the fact that London's industrial advantages are becoming generally known to the American manufacturers point to unprecedented industrial activity in the "Forest City."

The John F. Byers Machine Company, Ravenna, Ohio, have issued Bulletin No. 1007, under date February 1, describing their Model C auto-crane—the kind of laborer that never quits and solves the labor problem to a very considerable extent, in that it is equal to twenty men, at low operating cost. This auto-crane will travel any place a motor-truck can go. The bulletin describes the crane and its mechanism in detail, and reproduces a number of interesting photographs illustrating the type of work that can be readily accomplished by its use. The manufacturers have just made arrangements with the F. H. Hopkins Company to handle this equipment in Eastern Canada.

The car situation in Montreal is affecting the building situation. It is increasingly difficult to deliver brick and other material, and, although there is at this season comparatively little construction work, some jobs are held up owing to the want of transportation facilities. This is, no doubt, of a temporary nature, but it involves a certain amount of extra cost. Prices of commodities, too, are again advancing, making building dearer and deterring firms from doing anything except such work as is absolutely necessary.

There is a shortage of tin-plate in Canada, according to the Department of Trade and Commerce.

NEW WESTMINSTER

THE industrial conditions in this district have improved to a considerable extent during the past year, and the projects for the present year appear to promise a further improvement. The sawmills are all busy, and are running to their full capacity. The shingle mills are running double shift. Two new shingle mills have been erected during 1916, and one is being erected to replace a mill destroyed by fire. The box factory had a good year, and expect to be running to their full capacity during 1917.

This being the year of the expected big salmon run, all of the canneries are making their preparations accordingly. The Laminated Materials Company are running their factory to capacity. The machine shops are fairly busy. There are three shell factories located here, and they are running to full capacity with a double shift.

Messrs. Leckie & Company, the shoe manufacturers, of Vancouver, B.C., have taken over the tannery and are putting it in condition for operating in the early spring.

A New Westminster flour mill - Typical of Western Canada's greatest source of wealth.

The improved water front property belonging to the city is being taken up by industrial establishments, as its water and rail transportation facilities are being recognized by industrial concerns.

The Northern Pacific Railway Company is at present building a freight shed on the water front they have leased from the city.

A large evaporating plant was built on another part of the water-front which is operating a double shift. This plant evaporates potatoes, onions, carrots and all kinds of vegetables. Practically all these factory buildings are of timber construction, and covered with galvanized iron.

The Canadian Northern Railway Company's car shops at Port Mann are at present being put in condition for operating. The factory building is of reinforced concrete construction throughout.

By Mr. Thos. Turnbull, Building Inspector.

Mr. William McNab, valuation engineer of the Grand Trunk Railway, on February 21st read a paper before the Washington Society of Engineers on "Types of Modern Railway Construction in Canada."

Descriptions and Illustrations of a Few Types

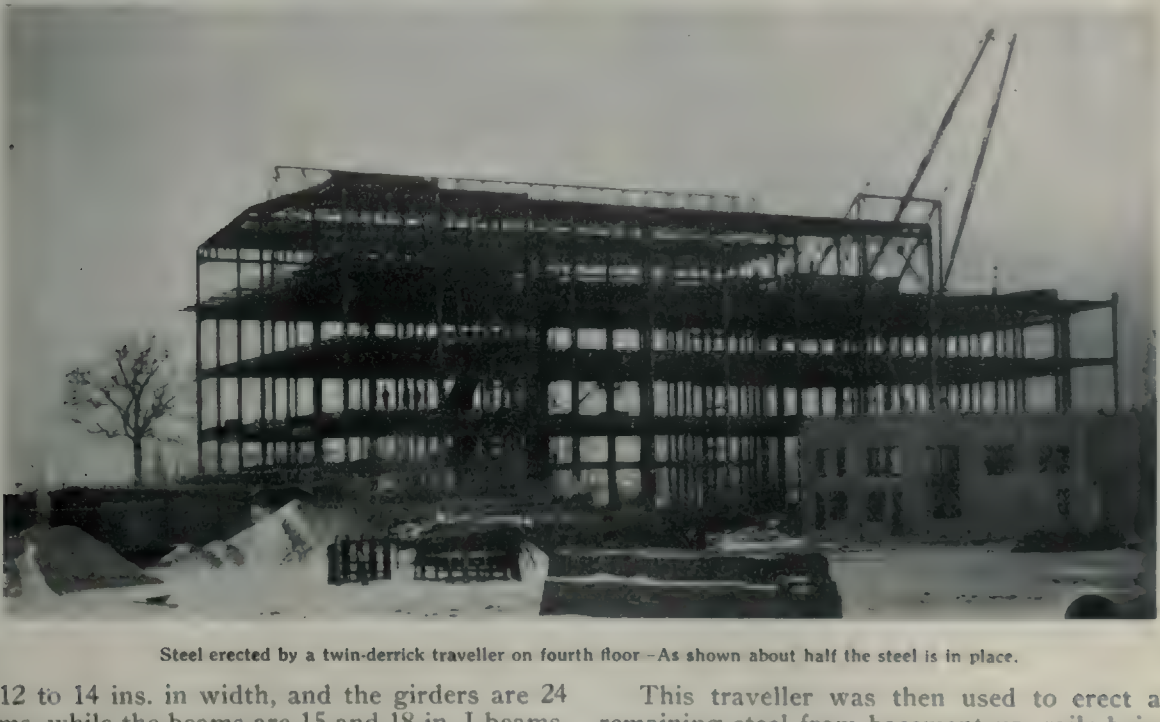
of Canadian Industrial Activities—Cover a Very Extended Range—The Stability of Her Buildings and the Quality of Her Products Guarantee a Glorious Future

Goodyear Rubber Factory

A 2800 ton steel frame structure—Erected with a twin derrick travelling erector

THE new factory building now in course of construction for the Goodyear Tire and Rubber Company, at New Toronto, Ont., is a steel frame structure with brick walls and fireproofed with concrete. The plant consists of a main factory with a separate power house, which is interesting in that it contains the second largest chimney in Canada, a Custodis radial brick structure, 250 ft. high by 14 ft. internal diameter at the top. The methods of erecting the steel, of which there is 2,800 tons, show some interesting features, a little out of the ordinary, and it is the purpose of this article to describe only the erection methods in more or less detail.

The factory measures 100 ft. by 460 ft. in plan, divided into five bays along the width and 13 bays along the length, each bay being 20 ft. square. The building is four storeys and basement in height. The steel work is not intricate in any way, simple columns, girders and beams being used, the beams intercepting the girders at the third points. The columns are of H section, 12 to 14 ins. in width, and the girders are 24 in. I-beams, while the beams are 15 and 18 in. I-beams. The roof is carried on steel trusses of 40 ft. span and spaced at 20 ft. centres. Along the roof of the building in the centre, is a skylight supported on triangular skylight trusses of 10 ft. span and spaced at 6 ft. 8 in. centres. The general scheme of the steel work is apparent from the illustration reproduced herewith. The total weight of steel contained in the structure is about 2,800 tons.



Steel erected by a twin-derrick traveller on fourth floor—As shown about half the steel is in place.

For erecting the members, a special traveller erector was made use of, which, although, perhaps, not unusual, is of interest inasmuch as it facilitated operations and made for speedy work. The traveller was also arranged to be of use on other jobs when its work at this factory was finished.

In beginning the erection a stiff-leg derrick was set up on the basement grade. This derrick had a steel lattice-work boom 75 ft. in length, with two steel latticed stiff-legs and wood sills. It was used for unloading the steel and for setting the cast iron grillages on the concrete foundation piers. This derrick then erected the steel for the first four longitudinal bays, the full five bays wide, up to and including the second storey of steel. Another hoisting engine and a derrick similar to the one mentioned, but with steel sills were then placed on the second floor, using the basement derrick as its erector. This derrick assembled two more floors for the four longitudinal bays and on the fourth floor of steel, the traveller was placed. Using the second floor derrick, a steel lattice-work 75-foot boom was braced on one corner of the traveller base. This derrick was then used to lift the second floor derrick and set it on the other corner of the base, thus making a twin-derrick traveller. The hoisting engine from the basement was picked up and with a second one, was set on the traveller.

This traveller was then used to erect all of the remaining steel from basement up, rails being laid on which the erector moved as work progressed. The derricks were operated from independent hoisting engines and one derrick erected in front, taking four bays, four storeys high. The other derrick assembled the roof and one bay four storeys high.

The traveller base was made up of 8 in. x 8 in. column sections, using two side rails each composed of a pair of shapes, transversed by six single shapes, grouped four near one end and two near the other, the engines being supported on the four beams and the derrick on the two. Single truck wheels at the corners spaced 30 ft. apart in both directions carried the rig on rails. The derricks were both of steel, the booms being 75 ft. laced steel. The masts, about 25 ft. high, were made of two 8 in. channels laced, with side sills of steel and a double headed cross sill. Four laced angle irons formed the stiff-legs, tying the masts to the side sills. The masts were tied with a top strut of two 8 in. channels laced and braced with angle iron cross-bracing. The two hoisting engines were of 18 and 22 horse power each, respectively, provided with two drums and completely housed in frame sheds. A rather unusual feature for travellers of this kind was the use of bull wheels on the masts with a sluing gear on the engines for swinging the booms instead of lines. The bull wheels which were composed of two channels bent to semi-circular forms were not only braced to the mast, but also to the boom, so as to take up momentum thrusts. The sluing gear of the engine was of the usual type with two drums operating through a friction clutch from gears on the engine and so arranged that one or the other could be geared up to rotate the boom in the direction desired. The capacity of each derrick was five tons.

The traveller was arranged so that the component parts were of use for other arrangements. As indicated, the booms were employed on plain stiff-legs and may be used as gin poles. The stiff-legs, bracing and masts are all adaptable for other purposes. The steel was delivered to the site on cars and transferred by motor truck.

McGregor & McIntyre, Limited, of Toronto, are the steel contractors.

Turnbull & Cutcliffe, Limited, Brantford, have been awarded the contract for the roofing and sheet metal work in connection with the addition to the Penmans Mills and the Y. W. C. A., Paris; also the roofing of the Galt Reporter premises, Galt.

A Montreal Box Factory

A four-storey flat slab reinforced concrete building of attractive appearance—Materials made in Canada

A FOUR-STOREY reinforced concrete building was erected in Montreal this past fall and winter for the Thompson & Norris Company of Canada, Ltd., by the Atlas Construction Company, Ltd., of Montreal, working from plans prepared by Lockwood, Greene & Co. of Canada, Ltd., engineeers, of Montreal.

The building will be utilized by the owners for the manufacture of corrugated boxes and shipping cartoons, the raw materials—straw-board and paper—being received from other plants. This plant is a branch of the United States company, which operates factories at several cities, including a plant for the manufacture of the straw-board.

The new building in Montreal is constructed entirely of reinforced concrete of the "flat-slab" type, the "two-way" system of reinforcing being used. It is designed to be ultimately seven storeys high, but the exterior treatment has been such as to give the present structure the appearance of a complete building. In fact, the exterior, when finally finished down, will present an unusually attractive appearance, as the engineers endeavored to save the building from the commonplace appearance so usual in concrete structures.

The Thompson & Norris paper box factory will have an attractive appearance when completed.

The Thompson & Norris Company own land on Masson Street, in Delorimier Ward, Montreal, adjoining the tracks of the Canadian Pacific Railway. The building is 102 feet wide on the street and 189 and 125 feet on the sides, the rear following the curve of the tracks. Adjoining, at one side, is the boiler house, of approximately 1,500 square feet, designed to contain three boilers, and a 125-foot Custodis chimney.

At the front and rear corners, on the longer side, are located stairs, freight elevators, and toilets, while the front stair has been arranged so that a passenger elevator can be located in the well in the future. There are two entrances from the street, one of which is intended for the office.

The shipping platform at the rear, at the second-storey level, is built over a concrete tank to hold the silicates used by the company as paste. A concrete and steel slide running across the tank near the centre makes it possible to slide the bundles of straw-board from the cars directly to storage in the first storey. The railroad siding alongside the boiler house runs on a trestle, carried on concrete bents, to form the coal storage yard.

The flat slab construction of Thompson & Norris building provides unusually neat and clear storey space.

The exterior walls are built of a brick facing on hollow tile. The windows are filled with standard steel sash. All interior partitions are hollow-tile, plastered in the stairways and toilet rooms. The temporary roof is carried above the future fifth floor slab on a wood frame made of the form materials. The floors above the first are of maple, laid on 1 in. x 6 in. boards on a ½ in. sand bed.

It is interesting to note that all materials used in the building, except the chimney and the Pellee doors for the elevators, were "made in Canada."

The Atlas Construction Company began work on August 16. The concreting of the reinforced footings began August 23, of the second floor slab September 19, and the last structural work was poured on October 30. Slab forms were made up in battened panels, 4 ft. x 12 ft., and supported on 2 in. x 10 in. stringers, 24 in. on centres. Owing to the impossibility of getting steel forms for the round interior columns in requisite time, it was necessary to build them up of wood. The flaring heads were formed in molds made up of radiating boards, whose edges were cut to the necessary curve. Spaces between boards were stopped up with paper, shavings, etc., and the whole surface made smooth and regular with cement mortar. A final coat of plaster of Paris finished the mould. Both head and column forms were made in two sections for convenience in removing.

All glass had been set by November 25, and most of the interior work was finished in January. However, it was necessary to close down the work on February 3 because of lack of coal. The exterior concrete work will be finished down in the spring, and the plastering of pent-house completed.

The job was so situated that two towers were utilized in concreting. No skilled labor was necessary in placing the steel reinforcing beyond the services of a foreman, as the drawings were clear and the system of reinforcing simple. The design was such as to allow column and beam forms to be used from storey to storey without much change.

The entire work was supervised by Mr. Leslie B. Ellis, as resident engineer for the owners and engineers. Mr. Ellis also designed the boiler room piping, auxiliaries, and smoke flue on the job.

The heating system was installed by the Garth Company, of Montreal. The low pressure boilers were supplied and set by Ross & Greig, of Montreal, agents for the Goldie & McCulloch Company, of Galt, Ont.

A Western Canada Warehouse

Mill constructed building with British Columbia fir — Typical of substantial structures erected in our western cities

THE illustration herewith shows the warehouse for Campbell, Wilson & Horne, Limited, one of the latest commercial buildings in Red Deer, Alta. It is of mill construction with B. C. fir posts and beams, the posts being solid and the beams laminated. Concrete is used for basement walls, footings, post foundations, basement floor, floor and ceiling of vault, fuel chamber and boiler room partitions, window sills, and fire wall copings. The outside surface of the foundation walls is finished with a 1:2 cement mortar and blocked off to resemble masonry. The forms were made of No. 1 shiplap with 2 x 4 in. studs at 2 ft. centres. The form boards were used for roof boards after cleaning.

The proportions for the concrete walls were 1:2:5. The basement floor was four inches thick, of concrete in the proportion 1:2:3, finished without top dressing. The vault floor and ceiling are of concrete, 4 inches thick, reinforced with ⅝ in. diameter steel rods placed at 8 in. centres and at right angles to each other, and finished with a 1:2 cement mortar. The window sills and copings are cast in place and provided with a sand finish.

The exterior walls are of brick, with an air space of two inches between the outer face brick and inner bricks, the walls having a total thickness of 15 inches. The space between bricks is maintained by galvanized iron brick bonds placed every 4 feet and every 10 courses in height. The vault is built of hard burnt clay brick, 15 inches thick, with a 2 in. air space.

The floor is 2 x 8 in. laminated spruce, covered with building paper and finished with ¾ in. maple.

Heating is by low pressure steam, heat being supplied to ground floor only. The boiler has a capacity capable of maintaining an internal temperature of 70 degrees when the external temperature is 30 degrees below zero. There is an elevator of 3,000 pounds capacity, electrically operated.

The roofing is four-ply asbestos and the under side of roof between rafter and purlins is sheathed with ½ in. boards covered with tar paper, to prevent condensation.

Mill constructed warehouse in Red Deer, Alta.

A Steel-Billet Foundry

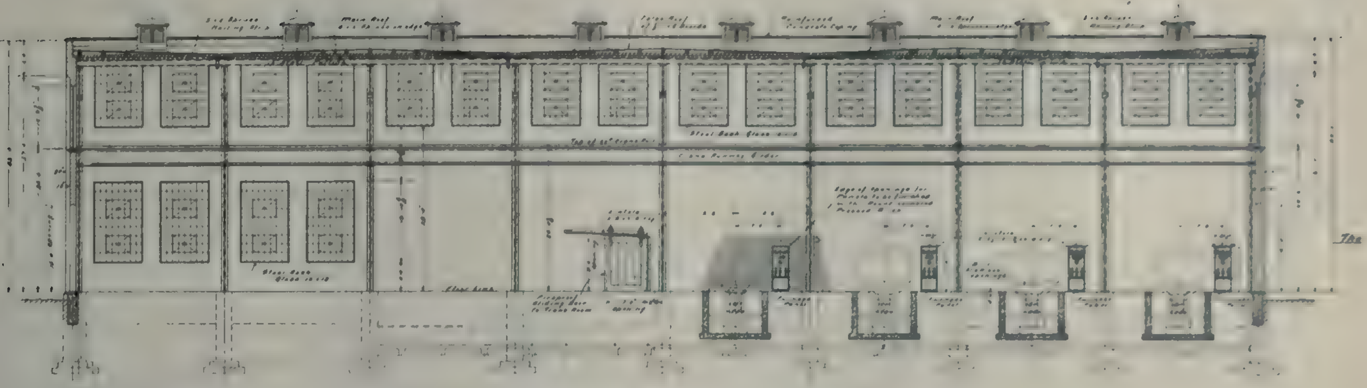
New plant has excellent transportation facilities and is within reach of abundant electrical power

THREE main factors were considered in the location of a foundry for steel billets now being erected at Cote St. Paul for the Thomas Davidson Manufacturing Company, Ltd., Montreal, from designs by J. M. Robertson, Limited, Montreal—proximity to the source of electrical power, easy distance to the other plant of the company, and transportation facilities. Various sites within Greater Montreal and also at other points in the province were discussed, but the one selected was considered to offer the greater advantages and to fill the chief requirements. First of all, the site is near the steam power plant of the Montreal Light, Heat, and Power Company and the substation of the Cedars Rapids Power and Manufacturing Company, with an available power of 50,000 kw.; secondly, the existing plant of the owners can be reached within fifteen minutes; and, thirdly, the Grand Trunk Railway sidings run right on to the property. Besides these there was an existing building, formerly belonging to the Dominion Marble Company, which could be easily adapted to the purpose in view—in fact, the nucleus of a plant.

The entire property measures 140,000 square feet, only a part of which will be now used, leaving room for future extensions. The building in course of erection is a steel foundry, measuring, inside dimensions, 200 feet long by 52 feet wide, while the electrical equipment necessary for operating the electrical furnaces, etc., will be housed in a structure 150 feet by 20 feet, semi-detached from the main building. This will contain on the ground floor the transformers and the oil tank room, separated by an 8-in. brick wall, the motor-generator sets, and the switchboard equipment, the two being located in galleries. The transformer house, as it is termed, will have a steel stairway of inverted channels filled with concrete.

The foundry proper is erected on concrete piers, owing to the original swampy condition of the ground, the footings being 12 feet deep; the walls, of plastic brick set in cement mortar, are built on reinforced concrete beams, with steel columns and steel trussed roof. The roof itself is of 4-in. mill construction, while the roof of the transformer house is of reinforced concrete; a coping of the same material will run practically right round both the foundry and transformer house. The ventilators are of wood. Fenestra sashes, with wired glass and reinforced concrete sills, are to be used, there being 6,000 square feet of glass area. It is of great importance that there should be ample light, and for this purpose the building is designed with a large number of windows. All the principal doors will be fireproof.

The new building is to be one storey, 42 feet high inside, while the existing building is partly one storey and partly two storeys. A portion of the latter structure will be used as a cutting-off room and for inspection, while the balance will in the future be devoted to a grey iron foundry. In the main bay of the foundry will be located four six-ton electric furnaces of the single-phase type, the pouring floor, and the ladle pits. The flooring around the furnaces will consist of scoria blocks on a 6-in. foundation of concrete, it being imperative to secure a flooring which will be absolutely fireproof. With one exception all the other floors will be of concrete. The ladles will be heated by oil, pumped from the oil tank room, below the machinery



Elevation of steel-billet foundry.

room floor. This oil will be conveyed by gravity through a spout on the exterior of the building, the oil being unloaded direct from oil tank cars. A portion of the machinery for operating the furnaces will be protected by removable reinforced concrete slabs.

A 20-ton overhead crane will be erected in the main bay, for the purpose of transporting all heavy material. A siding will run into the new building, and the material will also be unloaded by means of the crane. For conveying material to the furnaces, small dump cars, on rails, will be employed.

Adjacent to the main bay will be the scrap bins, into which the metal will be sorted. This portion of the building will be covered by a wooden roof. Unloading from the cars will be done by a powerful electro-magnet, and it is also proposed to instal a 150-ton track scale for weighing the scrap. The cutting-off room adjoins the shipping room, which opens on to one of the railway sidings, a large platform enabling the billets to be readily transferred to the cars. The offices will be located in the second storey of the old building.

The water supply is to be obtained from the Lachine Canal, and will be pumped into a large water tank.

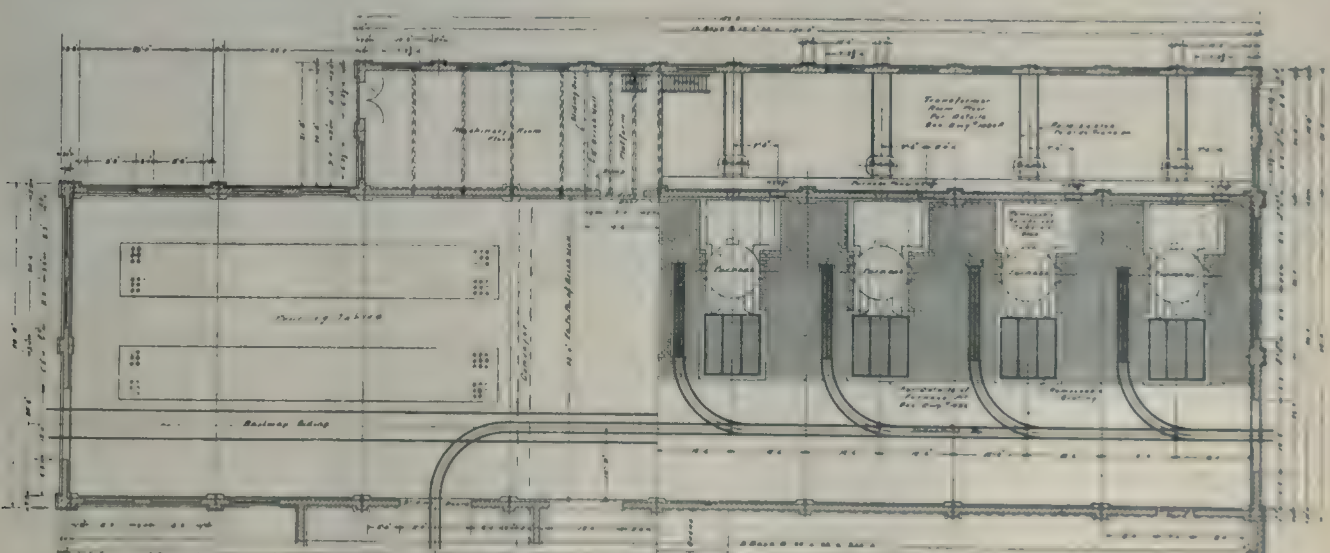
The electrical equipment will consist of four 1,350 kv.a. transformers, two motor-generator sets, and switchboard for controlling the furnaces, generators, etc. Power will be transmitted from the substation by means of a submarine armored cable, which will pass under the Lachine Canal, the cable being designed for a maximum of 5,000 kv.a.

The contractors are A. F. Byers & Co., Montreal. The contract for the steel (250,000 pounds) has been let to the Canadian Bridge Company, of Walkerville, Ont. The steel sashes will be supplied by Steel and Radiation, Limited, and the glass by Pilkington Brothers, Montreal.

It is stated that a corps of engineers is engaged upon an examination and inspection of all power company plants at Niagara Falls, Ont., with a view to determine for the Ontario Government if the water is being utilized with a proper degree of efficiency or economy. It is believed that this may have an important bearing upon the production of power upon the Canadian side, to meet Hydro and other demands.

A report of a proposed sewerage system for the town of Aurora was submitted by the consulting engineering firm of James, Loudon & Hertzberg on February 27. The scheme will include a collecting system, low-level pumping plant and disposal works, at a cost of $87,600. The indications are that the work will proceed at an early date.

The Canadian Government Railways call for an increased appropriation of $11,150,000 for working expenses.



Plan view of steel-billet foundry.

Wm. Davies Packing Plant

Special designs to meet peculiar requirements—Completely insulated with cork—Four floors erected in twelve working days

THE enlargement of the packing plant of the William Davies Company on Front Street, Toronto, consists of four separate buildings, a cooler building, an abattoir, a tank house , and a stock pen. With the exception of the stock pen, which is of wooden construction, the buildings are built of reinforced concrete on the flat slab system, faced with brick. The plant is designed to allow considerable future extension.

The cooler building, shown in an accompanying illustration, is used for cold storage purposes. It measures 132 ft. by 84 ft. in plan, and is seven storeys high and is constructed of reinforced concrete on the flat-slab, two-way system, according to the Chicago code. The typical bay, of which there are eight and five along the length and width respectively, measures 16 ft. in both directions. The interior columns are circular, with flaring capitals and drop heads carrying the flat slab floors, which are reinforced on the two-way method. Over the loading court, located at one corner of the ground floor, steel truss girders are used to give a clear loading space. The outside columns are rectangular in section, and a unique feature is that there is a double row of columns, with a 4 in. to 6 in. space between them. This is to allow the walls to be completely insulated with cork. The double outside columns may be seen in figure. These columns are anchored together by anchor-rods.

The floors are designed for live loads varying from 125 to 250 pounds per square foot, and the present roof is figured to act as a floor in the event of the addition of another storey. The columns of this building are carried on spread concrete footings.

Completely Insulated With Cork

An unusual feature of this building is the insulation of the floors, walls and columns with cork to prevent heat transmission and radiation. The typical floor insulation consists of cork boards, 2 in. in depth, laid on the rough concrete floor in a hot asphalt mixture, and then covered with a granolithic finish. The freezer floor has 4 in. cork and 4 in. finish. The walls of the buildings are composed of 8 in. of Denison hollow tile, faced with 4 in. of brick, and covered on the inside with cork board 4 in. to 6 in. thick, plastered inside. The columns are similarly insulated with cork boards. The roof is of concrete and 6 in. of cork on a cinder fill covered with a combination roofing.

Heavy cooler type windows and doors are used, in keeping with the design and purpose of the building. Special equipment is contained in the cooler designed for the special requirements of the abattoir industry. On all floors there are racks hung from inserts set in the concrete, and overhead mono-rail carriers are employed for the movement of carcasses. Two elevators are provided and steel stairs are installed. The ground floor is arranged for a wholesale market, and is furnished with marble walls and counters and plastered ceiling.

Four Floors in Twelve Days

The concrete and materials were raised by means of two towers, and the concrete was distributed and deposited by buggies. Crushed stone and water-washed sand were employed as aggregates, and a 1:2:4 mix was used on floor slabs with a 1:1½:3 mix for columns. As evidence of the speedy work that can be done by buggies without chuting is the fact that four full storeys of the cooler building were constructed in twelve working days, these floors involving 45,000 square feet. This was done in spite of the fact that the weather at the time these floors were erected was quite cold and necessitated the provision of methods to prevent frost troubles.

For all cold weather building the aggregates were heated with steam pipes, located in the bins, and the water was also used hot. Salamanders were used to supply heat, and the cold was kept out by tarpaulins, as shown in figure.

Another instance of speedy work was the installing of 43,000 feet of brine piping in eight days.

The abattoir located next the cooler building is five storeys in height, constructed on exactly the same plan as the cooler building. It measures 82 ft. by 97 ft. in plan. The flat slab system is used, but the outside columns are not made double, as in the cooler building. The foundations in this case are carried on piles, since the ground here is so groggy as to prohibit concrete spread footings. The piles are of wood and were driven with a steam hammer. The walls of this building are solid brick, 14 in. thick, and the floors are designed for live loads varying from 125 to 200 pounds per square foot. The top floor, being used for killing, is made 25 ft. in height. Towers and buggies were used for concrete distribution. Cork insulation is not used except in special situations.

Cooler building under construction during cold weather. Note double exterior columns.

Tank House

The tank house is a building 130 ft. long by 129 ft., and 59½ ft. at the two sides, the back being at an angle. Flat slab construction is also used, and the foundations are on piles. There are three storeys in this building, with a concrete bridge joining it to the abattoir. A steel bridge unites the abattoir and cooler building.

The stock pens are contained in a three-storey wood frame building, covered with corrugated iron. A hog-run connects the pens with the tank house and abattoir.

The architects for the plant are Henschien & Mc-

Laren, Chicago, and the general contractors are Wells Brothers Company of Canada, Ltd. The Sun Brick Company are supplying the Denison interlocking tile.

Pulp and Paper Mill in Quebec

Description of construction and operation of large additions to mill at Cap Magdeleine—Chiefly steel construction

THE St. Maurice Paper Company, Ltd., operating a 100-ton ground wood mill at Cap Magdeleine, Que., just below the junction of the St. Maurice River with the St. Lawrence, and with extensive timber limits on the St. Maurice River, has in the year just passed made a notable extension to the pulp and paper industry of Canada by the addition of a large mill to their previously existing plant.

This addition consists of a sulphate and sulphite plant and a 100-ton news-print mill, together with pump-house, boiler-house, etc., made necessary by this increase. The buildings in general consist of a finishing room, 133 x 127, with train shed; a machine room, 88 ft. x 290 ft., a sulphate and sulphite screen room, a diffuser building, containing the diffusers and sulphate digesters; a sulphite digester building for two digesters, blow-pits, an acid plant, an evaporator, incinerator, recovery and salt cake storage building, boiler-house, pump-house and wood room. A new intake crip and pipe were made necessary; also some additions to transformer and switchboard rooms.

In general, the buildings are of steel frame construction, with concrete foundations and brick walls. The floor slabs are of reinforced concrete on steel framing; the roofs, excepting in the machine room building and wood room, where Siegwart beams are employed, are of concrete on metal lath, plastered. Steel sash were used throughout. The upper floor of the machine room, where the paper machines are located, was made unusually light by the use of a sand lime brick. The roof of this building is carried by trusses, spanning from wall to wall, the same being true of the boiler-house.

A progress illustration of the St. Maurice Paper Co. pulp mill.

Examination of the soil before construction commenced showed sand to a depth of 12 to 14 feet, and clay below that at least another 50 feet. The bearing power of the soil was found to be sufficient in the case of all the buildings except those containing the digesters and the blow-pits, where Raymond concrete piles were used.

The company's sawmill is located a short distance up the St. Maurice River, on the Three Rivers side, and the logs are taken out of the river at this point and sawn into sticks of suitable length for the grinders and chippers. These are then shipped in cars to the pulp mill. Those intended for use in the new mill are brought in on the outer rows of tracks and unloaded into conveyors to the motor-house, where they are sorted into those suitable for use in the sulphite process, and into lower grade material, used in the sulphate process.

From here the wood is conveyed to the sulphite and sulphate chippers respectively, in the wood room building, then to the chip screens, and on to the conveyors. The sulphite chips are carried to the chip bins over the sulphite digesters, thence to the 8-ton digesters, for cooking. From here it passes successively to the blow-pits screens, deckers, where it is mixed with ground wood, stock chest, and then pumped up to be used in the 166-in. paper machines.

Building pump house and installing pipe line at St. Maurice Paper Co. pulp mill.

The sulphate chips are carried on separate conveyors to the sulphate chip bins and thence to the sulphate digesters. From here the materials go to the diffusers, where the liquors are taken out, and the pulp goes to the stock chest. The liquor from the diffusers goes successively to the evaporators, melting furnaces, and dissolving tanks. After final treatment in the causticizing tanks, the liquor is ready for reusing.

The boiler-house is equipped with a coal crusher, the coal being then conveyed to overhead bunkers, from whence it is automatically fed under the boilers. These are arranged in three batteries, developing 6,000 h.p.

An idea of the amount of water required about a plant of this kind may be gathered from the fact that the present pump-house capacity was increased by twelve million gallons daily.

This plant was built under the direction of Mr. Edgar G. Barratt, Mr. Harry S. Ferguson being designing engineer; Mr. R. T. Young was resident engineer. The George A. Fuller Company, Ltd., were contractors for the work, Mr. H. F. Lincoln being in charge of the construction.

The piling was by the Raymond Concrete Pile Company of Canada, while the Siegwart beams were supplied by the Canadian Siegwart Beam Company, Ltd., Montreal; the steel, Structural Steel Company, Ltd., Montreal; steel sash, Steel and Radiation, Ltd.; roofing, the McFarlane-Douglass Company, Ltd., Montreal; glazing, Alexander Craig, Ltd., Montreal; the electrical wiring was by the Canadian Comstock Company, Ltd., Montreal.

Unusual Coal-Handling Plant

Contains new and interesting features, consists of three sheds, unloading tower and screening plant, with capacity of 150,000 tons

A COAL-HANDLING plant has recently been completed at Fort William, Ont., for the Fort William Coal Dock Company, which contains new and interesting features, and as it is of a rather unusual type, we believe a description will appeal to the readers of the Contract Record. The plant is intended for handling hard coal only. The coal is shipped from United States points, principally Cleveland and Buffalo, during the summer months, as long as navigation is possible. A considerable portion of it is handled directly to the cars after unloading, and the balance is stored and shipped during the winter months. The plant consists of three sheds, an unloading tower, and a screening plant, and has a total storage capacity of 150,000 tons, 50,000 tons in each shed. The ultimate handling capacity is, of course, greater, considering the quantity of coal which is conveyed to the cars immediately it is received.

The outstanding feature of the plant is the unloading tower, which is seen in Fig. 1. This tower is set up on wheels, supported by four heavy trucks, two on each side, and runs on two single rails, so that it can be moved in front of any one of the three sheds. As may be noted in the illustration, there are two rails running along the upper deck of the structure and forming a track, which extends along the boom overhanging the water. These rails are aligned to correspond with rails running at the same level in each of the sheds. Thus when the tower is placed in working position in front of any of the sheds there is a complete track from the end of the boom to the rear of the shed. Along this track a heavy crane, weighing about 30 tons, is operated. Attached to the crane is a large bucket, with a capacity of seven tons, and when unloading coal the crane is moved out on the boom and the bucket lowered into the hold of the vessel, from which it raises the coal. The crane is then run back into the shed and the coal is dumped. In this way a coal boat carrying some six or eight thousand tons of coal can be unloaded in about eight hours. (Fig. 2.) At the rear of the sheds is a screening plant, where the coal is screened into standard sizes for shipment, each class being placed in a separate bin, from which it is chuted directly to the cars. This screening plant is fed by the same crane which unloads the boats. The crane either conveys the run-of-mine coal from the shed where it is stored or during the summer months it may unload it direct from the vessel to the screening plant. The coal is loaded into cars on a siding of the National Transcontinental Railway, which runs into the plant.

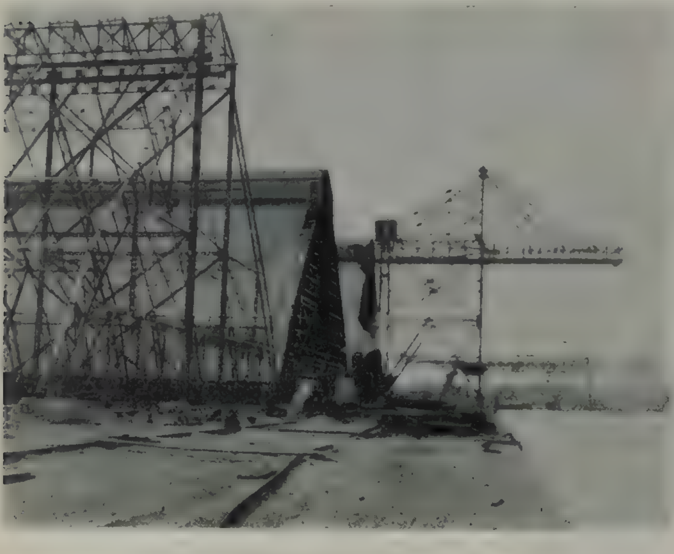


Fig. 1.—Unloading tower and storage sheds.

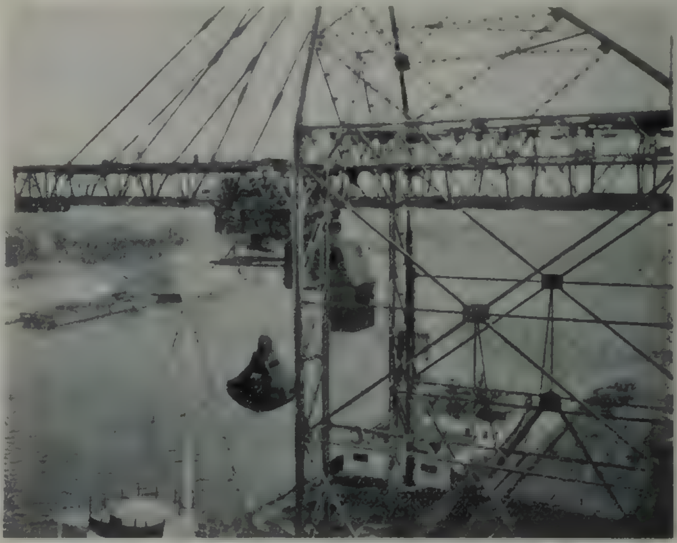


Fig. 2.—Unloading vessel with grab-bucket on unloading tower.

The Unloading Tower

The unloading tower contains 145 tons of steel and is 122 feet high and 40 feet by 50 feet in plan. The height from the dock floor to the top of the crane rail is about 77 feet. The boom is 64 feet long, and is supported by three lines of eye bars. It can be raised until within seven degrees of the vertical, to allow the masts of the ships to pass underneath. It is operated by a hoisting engine, driven by electricity, which is located in the operator's house at the back of the tower. As shown in the illustration, near the bottom of the tower, in front, there is a hopper, into which coal may be received for direct shipment without passing through the screening plant. The tower is moved along the tracks by electric motors located on the trucks and connected to the axles by a series of gears. It has sixteen wheels, four on each truck. At each rear leg of the structure concrete counterweights have been placed to prevent it overbalancing when unloading coal.

Storage Sheds

The storage sheds were erected of structural steel and covered with corrugated iron. The corrugated iron was not galvanized, but was painted, the latter being considered a cheaper method of protection from corrosion. The flooring is of heavy maple, laid directly on the ground. The sides of the sheds near the bottom are also lined with heavy timbers to take the coal pressure. Further up the sides of the building the pressure ceases, owing to the shape of the coal pile, which slopes away from the walls, its angle of repose being 27 degrees with the vertical. As will be noted in the illustration, the walls of the sheds have been shaped to conform to this angle. These structures are each 87 feet high and 133 feet by 414 feet in plan, the structural steel weighing about 450 tons per shed. An electric truck arrangement, with a scraper attachment, is employed for scraping the coal to the centre of the sheds, so that it will be in reach of the bucket of the unloading crane when it is desired to convey it to the screening plant.

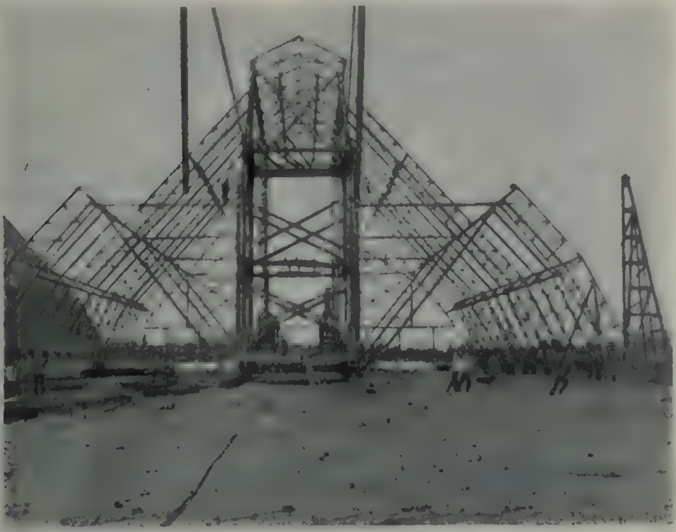


Fig. 3. A storage shed during construction.

Screening Plant

This plant, located at the rear of the sheds, contains 235 tons of structural steel. The coal is screened by means of a screening frame. This is a horizontal apparatus, which is set up on wheels, so that it can be moved from one shed to another, along a bridge which forms a connection between the three structures at the rear. At one end of this frame is a hopper, into which the coal is dumped by the unloading crane as it comes from the shed. In front of the hopper are five screens, set at a slight slope, one above the other. The coal passes from the hopper to the upper screen, which retains the largest grade of coal, and each successive screen is graduated to correspond with the standard grades of coal, egg, stove, nut, etc. The screens are shaken horizontally by an electric motor and rigged up to an eccentric shaft, the motion causing the coal passing through one screen to drop to the one beneath. Below the bridge along which the screening frame runs there are five bins at the rear of each shed, and into these bins each grade of coal is deposited from the screens. The cars run directly underneath these bins and the coal is chuted into them.

Erection Methods

The unloading tower was the first portion of the plant to be constructed. Erection was carried out by means of a timber traveller, about 40 feet high, on top of which were two wooden stiff-leg derricks, operated by two Beatty engines, located on the rear of the lower deck of the traveller. In erecting the unloading tower the traveller was set up on timber blocking on the dock floor and erected the steel around itself. By this means the tower was constructed as far as the upper deck. The remainder of the structure was erected by a stiff-leg derrick attached to the upper deck. The boom was also set up by this derrick, in the open position—that is, at seven degrees from the vertical. After the completion of the lower portion of the tower the traveller was moved back and proceeded with the erection of the sheds. After the work on one shed had been finished, the traveller wheels were turned 90 degrees, so that it could be moved laterally to the next shed. The wheels were then turned to their original position and the traveller was moved forward and the erection of the second structure proceeded with in the same manner as the first. The sheds were built on a foundation of concrete pedestals supported by wooden piles. In erecting the screening plant the traveller was used for part of the work and the remainder was carried out by a boom lashed to the rear of the shed.

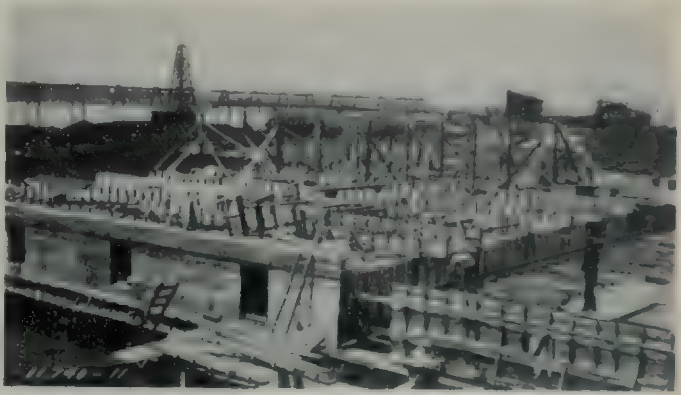
This coal-handling plant was erected at a cost of about $300,000. Great efficiency is claimed for it, only seven men being required for its operation. The Roberts & Schaefer Company, of Chicago, were the designers and general contractors, and the Dominion Bridge Company, of Toronto, carried out the contract for the fabrication and erection of the structural steel work. The unloading crane was supplied by the Brown Hoisting Machinery Company, of Cleveland, and the corrugated sheeting by the Pedlar People, of Oshawa.

Bleaching Powder Factory

Three sets of four chambers each made of dense, impervious concrete to prevent leakage of gases—Concrete block walls

THE Canadian Salt Company have recently completed additions to their plant at Sandwich, Ont., which double the number of their bleach powder chambers and will double the plant's production of bleaching powder. The additions consist of a new chamber building, 288 feet by 115 feet, which is an exact duplicate of their first unit, and a lime house 49 feet by 42 feet, which is a wing of the chamber building.

The foundation of the chamber building is of concrete, the frame is of timber, and the walls are of concrete blocks, 8 in. x 8 in. x 16 in. About 20,000 blocks were used in the building. The floor is of 6-in. concrete; the roof is of three-ply felt and pitch, and there are no intermediate floors except the runways around the chambers.



Progress photograph of bleaching powder plant of the Canadian Salt Co.

The building contains three sets of chambers, each set comprising four chambers. Each chamber is 20 ft. by 100 ft., with reinforced concrete walls, floors and roofs. Density and imperviousness are the essential characteristics of the concrete used in the chambers in order to prevent leakage of gases through the concrete and to prevent the gases from attacking the steel reinforcing bars. The concrete was all placed by the gravity system, and by this method it was found possible to mix and place a sufficiently dense grade of concrete at a reasonable cost. The tower was used in three different locations, each one opposite the centre of the set of chambers. Each chamber required 400 yards of concrete, ten and a half tons of reinforcing, and about 4,400 square feet of forms.

Exterior view of bleaching powder factory of Canadian Salt Co.

The lime house is of timber frame with a few reinforced concrete columns, and the walls are of concrete block corresponding with the chamber building.

Bleaching powder is manufactured by mixing chlorine with slaked lime in the chambers, and lead chambers are ordinarily used in the process, but the Canadian Salt Company have for some time been using concrete chambers with success.

It was anticipated that trouble might be encountered in prosecuting this work because of unfavorable labor conditions, but the work was completed on time with no trouble whatsoever.

These extensions were designed by the Canadian Salt Company and constructed by Westinghouse, Church, Kerr & Company, of Montreal and New York.

Mr. R. O. Wynne-Roberts has entered into an arrangement with Mr. Frank Barber by which he will be associated with him in connection with the York Township water scheme and other works, and will conduct his practice as consulting engineer until the end of March at 57 Adelaide Street East, Toronto, when new premises will be taken.

Temporary Munition Plant

Wooden buildings to meet the requirements of shell manufacture—A typical instance of this kind of construction

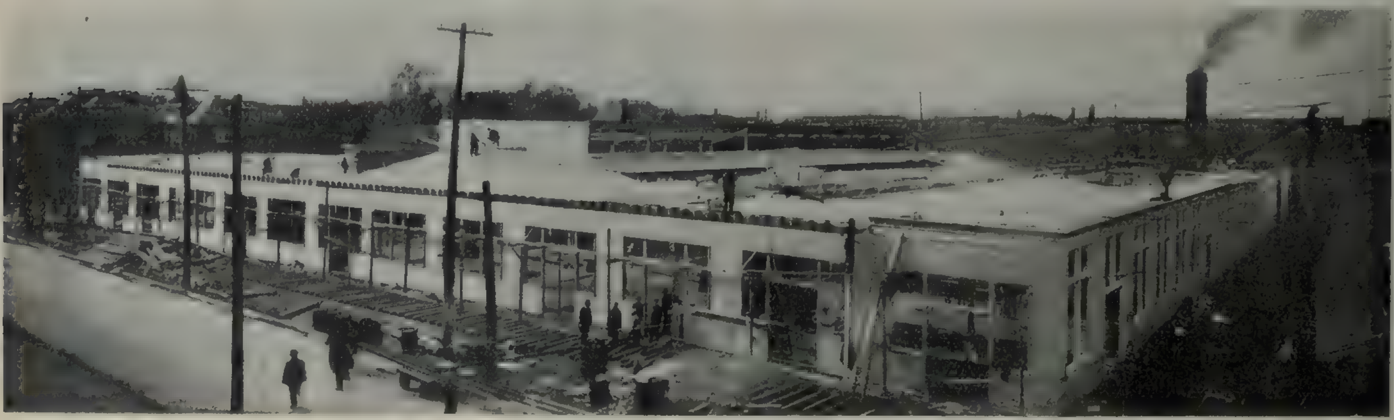
THE illustration shown herewith gives an idea of a type of munition factory being erected throughout Canada for the manufacture of shells. This plant, belonging to the Russell Streets, Toronto, and was intended as a purely temporary factory for munition work, to serve during the war. The city by-laws would ordinarily prohibit the Motor Company, is located on Dufferin and Liberty erection of factories of this type, but the urgency of the situation has caused the stringency of the by-laws to be reduced temporarily, provided that the buildings are either removed or converted to permanent factories after the war.

This particular factory is built of wood, and in its design every consideration was taken of the fire risk. It is a single-storey structure, measuring about 289 ft. by 190 ft., with a projecting wing on one corner 67 ft. by 56 ft. The cross-section shows a large ventilating monitor and two triangular-section skylights. The columns are 10 x 10 timbers, carried on 2 ft. square concrete piers, carried 2 ft. 6 in. to 3 ft. 6 in. below grade. The columns are spaced 14 ft. in one direction and 19 ft. in the other. The roof is carried on trusses built up of 6 x 6, 8 x 8, and 8 x 10 timbbers. They are spaced at 14 ft. centres, and have spans of 19 ft., except the monitor trusses, which span 38 ft., no intermediate columns being used.

The purlins are 4 x 8 timbers, spaced at 4 to 5 ft. centres, covered with 1¾ in. sheeting and ready-roofing. The walls are composed of ⅞ in. T. & G. sheeting, covered with building paper and ready-roofing, fastened with cleats. Three-inch yellow pine planks, laid on 4 x 6 B.C. cedar sleepers, bedded in a 4 in. cinder fill, form the floor.

A shipping building of similar construction is built alongside the factory, with a crane runway 371 ft. long, the crane having a 19 ft. 2 in. spread. Between the existing and the new factories there is a fire-wall, a similar wall separating the boiler-room. A 125 h.p. boiler provides steam for indirect heating through fans and ducts, located near the roof. The machine power is electric.

This building was erected in about 50 days by the Deakin Construction Company. Prack & Perrine, Toronto, were the architects and engineers.

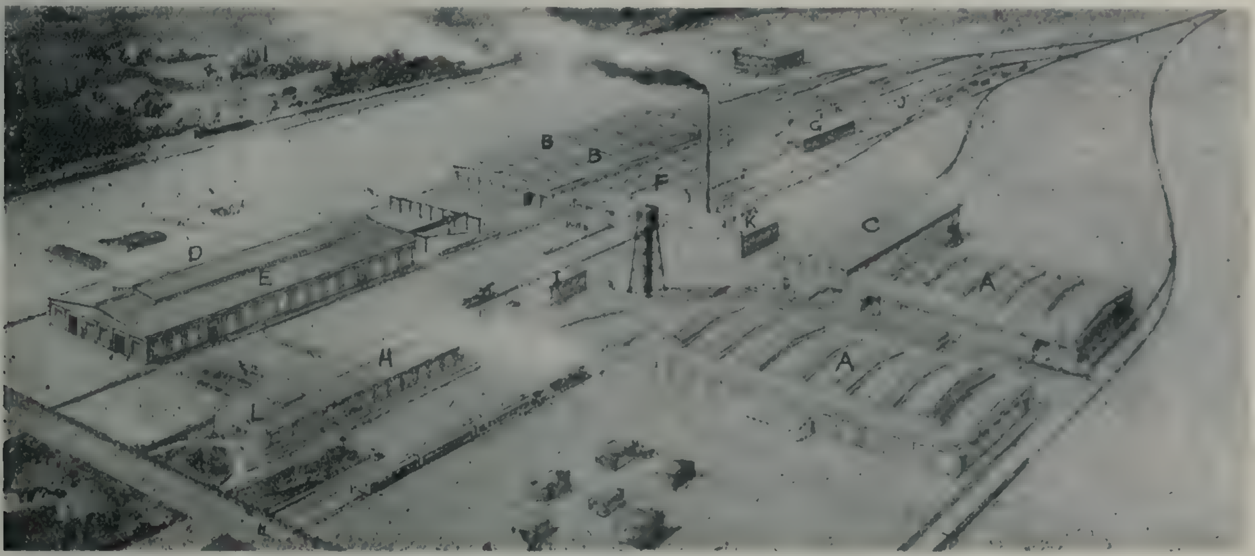


Wooden buildings erected to meet the urgency of shell requirements.

Grand Trunk Car Shops

A Group of buildings at Port Huron, Mich., for the manufacture of railway cars—Layout planned for economical working

THE layout on the ground is simple, the various buildings being grouped round the power plant at convenient though ample distances. The offices will be situated at the city end of the site, fronting to 28th Street and standing back from the street line about fifty feet, which will allow of a good approach. The list of buildings is indicated as follows in the accompanying bird's-eye view:—A-A—two passenger car shops; B-B—two freight car shops, for wood and steel cars; C—cabinet shop; D—blacksmith shop; E—machine shop; F—woodmill; G—day lumber store; H—general storehouse; I—paint store; J—drying kiln; K—power plant; L—general offices.



General Layout of Grand Trunk Car Shops.

Buildings

The power plant will consist of six return tubular boilers totalling 900 boiler h.p. The boiler pressure will be 150 lbs. per sq. in., and four of the boilers will be fitted with superheat giving one hundred and fifty degrees of superheat when coal is used and 200 degrees when wood refuse is used.

The boilers will be adapted for hand firing, as this arrangement would appear to be best on account of the large amount of refuse, varied in character, which will be burned. Other units for developing power for lighting and operating will be:—Two impulse turbo-generators of 300 kw. each to be used for generating three-phase electrical energy at 440 volts, the usual low power factor being raised to a high figure by the use of a synchronous motor-generator supplying the necessary direct current power; two air compressors of 1,500 cubic feet capacity of the cross compound type specially adapted for use with superheated steam.

The superheat of the air compressors may be controlled by proportioning their supply of wet steam. Boiler feed and vacuum pumps and open type feed water heater of 1,000 h.p. capacity will also be installed. The boilers will be provided with a steel stack 15 feet above grade and 6½ feet in diameter.

The heating requirements for the shops will be considerable, due to the large amount of special work in the nature of painting and varnishing, and altogether 50,000 square feet of radiation will be necessary. This will be supplied by exhaust steam from the power house in cast iron radiators of the wall type.

Coal will be directly delivered to bunkers inside the power house by means of hopper cars discharging through a steel trestle.

The Passenger Car Shops

The passenger car shops are so planned that each car under construction or repair occupies one bay of either building with a liberal allowance between the cars for working. These two buildings are built parallel to one another with a space of 100 feet between occupied by a transfer table which serves both. The construction is of concrete foundation, brick walls with steel windows. The roofs are designed with monitors which run across the length of the building and so light and ventilate each individual bay.,

Freight Car Shops

The freight car shops (steel and wood cars) are planned for the cars to enter at one end and leave at the other, the construction being similar to that of the passenger car shops, except that the monitors on the roof run from end to end instead of side to side, and the buildings are attached instead of being divided by a transfer table pit.

The cabinet shop is a two-storey building, the construction being similar again to the passenger car shops.

Blacksmith and Machine Shops

The blacksmith and machine shops are planned in a similar manner to the freight car shops, i.e., side by side, with a fire wall dividing, and the construction again is brick walls and tar and gravel roof.

The woodmill will be of different type of construction to the foregoing, being entirely wood-framed on a concrete foundation. This wood framing will be of a substantial type, and the walls will be formed with 2 inches of concrete reinforced with expanded metal, thus making a permanent finish which will be fireproof. This roof also will be tar and gravel. All windows will be steel sash.

The store building will be constructed on the same lines as the car shops with brick walls and heavy wood frame and tar and gravel roof. Office space for storekeeper and staff is provided at one end of this building.

The paint store is to be of fireproof construction throughout with a reinforced concrete slab roof on brick walls and concrete floor.

Dry Kiln

The dry kiln is a specially designed building in two sections with sliding doors at each end, thus enabling a carload of timber to enter at one end and be removed when dried at the other, no delay or inconvenience being occasioned, through having to remove one car to get at or remove another, and each section will be separate from the other and capable of being used independently. The heat will be supplied by means of steam pipes located below rail level, and a special system of air ducts will provide ample air changes which will be capable of regulation, and provision will also be made for the introduction of steam as required. The walls will be insulated by air cavity and also the roof, so that even temperature may be maintained.

General Offices

The general offices will be attached to one end of the stores building and will be of similar construction with a brick firewall dividing. The offices will be divided internally with hollow terra cotta walls, and the outer walls will be lined inside with the same material, all surfaces of walls and ceilings being plastered and painted.

Ample sanitary accommodation and lockers will be provided in each building for a full complement of workmen when the plant is in operation.

Ample storage spaces for steel, wheels, lumber, etc., have been allowed and the layout generally has been planned with special attention to economical working.

Lumbering a Big Industry

Description of an extensive enterprise on the Georgian Bay, Ont. — One of the largest mills in the province, with timber holdings of 1,000 square miles

ONE of the most extensive and important industrial enterprises on the north shore of Georgian Bay is that of the Spanish River Lumber Company, Limited, whose head offices are located at Massey, Ont., on the Soo branch of the Canadian Pacific Railway, about 18 miles east of Georgian Bay. The Spanish River Lumber Company, Limited, have been operating from this point for about 35 years, and since 1904, when its affairs passed into the hands of its present owners, the operations have been constantly enlarged, until today the company is among the largest operators in the province. Their timberland holdings exceed 1,000 square miles, and under normal conditions they operate from 8 to 14 lumber camps annually, besides employing a number of small jobbers. Their annual production amounts to several hundred thousands of logs, chiefly white and Norway pine.

Equipment of the Mill

At Cutler, Ont., on the north shore of Georgian Bay, the Spanish River Lumber Company, Limited, have been operating, for two years past, a fine new mill which was completed in the early part of the summer of 1915. This plant is equipped with two single-cutting Waterous 8-ft., new model, band mills with Prescott carriages; two 11-in. gunshot steam feeds, and lumber sorting tables furnished by the Waterous Engine Works Company, Brantford, Ont., who also furnished the complete filing room equipment and a miscellaneous assortment of live rolls, transfers, etc. The equipment also includes a Mershon 7-ft. vertical resaw and a Diamond Iron Works 6-ft. horizontal resaw. The plant has a capacity of 125,000 feet in ten hours.

The mill at Cutler, which was built to replace one that was destroyed by fire in March, 1915, is a frame building 56 x 216 ft., with an addition for a lath mill 36 x 80 ft., and a sorting shed and table 30 x 224 ft. As will be seen from our illustration, the mill is designed to be high and roomy, with plenty of light and ventilation. It has cement foundation throughout and cement floors on the ground level.

Spanish River Lumber Company's mill at Cutler, Ont.

The lath mill is equipped with two Garland bolters and two Payette lath machines, together with the necessary machinery and sorting facilities for making pickets.

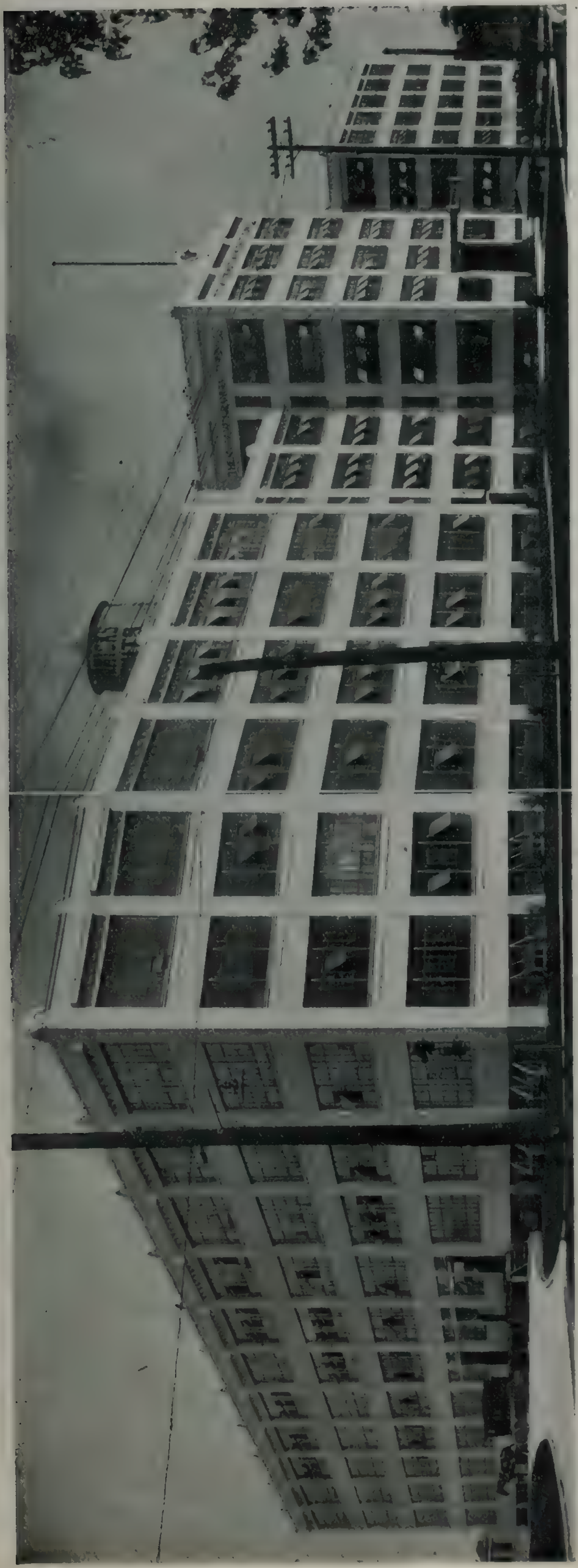
The plant obtains its power from a 600 h.p. twin Houston, Stanwood and Gamble engine, and nine 6 ft. x 18 ft. boilers.

The mill pond in connection with the plant at Cutler has a capacity of 70,000 logs.

The plant at Cutler has excellent shipping facilities, both by rail and vessel. The lumber docks and trams have been completely rebuilt and there is now accommodation for 12,000,000 feet of lumber for vessel shipment, which is supplemented by a land yard and trams for an additional 10,000,000 feet, which is available for either rail or vessel shipment. During the year 1916 this plant was operated night and day throughout the entire season.

Other Operations of the Company

The plant operated by the company at Spanish Mills is situated at the eastern end of Aird Island, about eight miles distant from Cutler. The mill was built in 1880 and has been in operation continuously since that time, with the exception of the winter seasons. At different times it has been extensively remodelled. Its equipment today includes a Waterous single-cutting band mill, a Diamond Iron Works twin band, Wickes gang, Prescott rift edger, and Diamond Iron Works horizontal resaw. The capacity of this plant is about 190,000 feet in ten hours.



Front view of McCormick Manufacturing Company's factory at London, Ont., which embodies every convenience for the health and comfort of employees.

A Notable Factory

Erected by London, Ont., firm, has pleasing architectural effect combined with utility, strength and durability

THE illustration herewith is of the new reinforced concrete factory building erected by the McCormick Manufacturing Company at London, Ont., which is a splendid example of the ideal attained in factory construction in Canada. In it a pleasing architectural effect has been combined with utility, strength, and durability. The main portion of the building is approximately 354 feet long by 91 feet in depth, with the wings in the rear. Exclusive of the basement, the building is four storeys in height. Provision for extensions has been made to amply take care of the future expansion of the business.

The whole exterior is of white terra cotta tile, attached to the reinforced concrete structural frame, and steel sash. The combination of reinforced concrete with steel sash affords maximum daylight, proper ventilation, and greatest permanency. The arrangement of the panes harmonizes with the general architectural features, and at the same time gives the maximum available area for lighting. A large amount of ventilation is secured by means of specially-designed pivoted ventilators.

The floor construction is of the flat slab design, and consists of solid reinforced concrete slabs, with no beams projecting underneath to cut off the daylight. The floor slabs are seven inches in thickness, and are designed for a live load of 150 pounds per square foot. In the packing room, where heavier loads are anticipated, the floor slab is nine inches in depth, and designed to carry 250 pounds per square foot. Circular, spirally-wound, hooped columns, with flaring capitals, have been used throughout the interior of the building.

The building is completely fireproof throughout; partitions are of metal lath, plastered to the required thickness with cement mortar. Metal lath is also used in the suspended ceiling over the oven room. The stairs are of solid concrete construction, with the concrete steps being moulded in place. The Kahn system standard design was employed throughout in the reinforced concrete work. The whole design of this factory shows careful study in the placing of ornamentation and a strong vertical feeling is present. It is unusually attractive in appearance, the main entrance being accented by the tower portion.

From the employees' point of view, also, this factory compares favorably with any other in Canada. Not only is their health provided for by proper ventilation and light, but there is a large self-serve dining-room, with a seating capacity of 600, a modern gymnasium, shower-baths, locker-rooms, library, and a complete hospital-room for emergency accident cases. The entire plant has eight acres of floor space.

Spring Convention of the Portland Cement Association in April

The spring convention of the Portland Cement Association will be held in the Palace Hotel, San Francisco, April 16-18, inclusive. This will be the first time in the history of the association that any of its meetings have been held west of Chicago. A special train has been arranged for the going trip from Chicago to San Francisco via the Northwestern, Union Pacific, and Southern Pacific route. This train will leave Chicago at 8 p.m., central time, Friday, April 13, and arrive at San Francisco at 9 a.m., Monday, April 16. At the conclusion of the committee and business sessions of the association it is planned that members attending will go in a body to Del Monte, Cal., and spend April 19 and 20 there in an outing.

Increase in Profits of Canada Cement Company for Past Year

For the past financial year the net profits of the Canada Cement Company were $2,218,848, a gain of $476,835. After providing for prior charges and 4½ per cent. dividend paid on the ordinary stock, $432,585 is carried forward. President W. C. Edwards reports that earnings from the cement business proper were more than sufficient to take care of all fixed charges, preference dividends and ordinary dividends chargeable to year's profits. "As stated last year, the producing capacity of the plants is considerably in excess of the country's requirements under prosperous peace conditions. We regret that the demand for cement during the past year was not sufficient to enable the plants to operate continuously."

The total trade of the port of Montreal for 1916 was $382,741,643, compared with $155,685,953 in 1915.

Mainly Constructional

East and West—From Coast to Coast

W. D. Baillairge, city engineer of Quebec, recently visited Toronto and other western cities in the search for information regarding the collection and disposal of city waste matter.

The Soo Dredging and Construction Company, Limited, which is now insolvent, has made an assignment of its property for the benefit of its creditors.

A scheme is proposed whereby the city of Hamilton will supply Barton township with water. The proposition is that the township erect tanks which the city will keep filled at a cost of 15 cents per thousand gallons.

Mr. W. F. Tye, consulting engineer, of Montreal, has been recommended by the works committee of Hamilton, Ont., to report on the feasibility of a common entrance and route through Hamilton for all railroads from the west.

The Department of Railways and Canals is releasing, on April 1, all engineers and office help engaged on the new Welland Ship Canal construction, work on which was discontinued some time ago.

Engineers have been making tests on both sides of the Niagara River for foundations for the $500,000 bridge which the Michigan Central Railway Company propose to construct in the vicinity of Niagara Falls, Ont.

During the months of January and February, building permits totalling $18,008 were issued in St. Catharines, Ont. The largest permit was for an addition to the Kenleith Paper Mill, valued at $9,000.

As soon as the plans for the Pape Avenue car line in Toronto have been passed by the Ontario Railway Board engineer, the Toronto Railway Company will proceed with the work of construction. The date specified by the board for starting work is April 1.

A number of contractors who, according to a government report, overcharged the town of Weston, Ont., $10,000 on its sewerage system, are settling the town's claim for $2,500, out of court. The contractors admitted overcharges of $700.

The city council of London, Ont., have decided to include in the City of London Bill, to be presented in the Legislature, provision for the erection by the Railway Commission of a modern grain elevator at Port Stanley. This would cost about $100,000, and would assure London of at least one large new industry this year.

Work is to be started shortly on the filtration system for the city of St. Hyacinthe, P.Q. The equipment to be installed includes a mechanical filter of 4,000,000 capacity, reinforced concrete reservoir, four filter tanks of 1,000,000 gallons capacity, two pumps, a steam turbine and electrical generators, etc.

Satisfactory progress is reported on the new public school in Galt, Ont., being erected by Messrs. P. H. Secord & Sons. The brickwork is now almost ready for the roof. The installation of the plumbing and heating systems will be under way within a week or two, according to the architect, Mr. Evans.

In pursuance of the policy of gradually replacing the wooden trestles on the Esquimalt & Nanaimo Railway with permanent steel bridges, a considerable portion of the appropriation for 1917 will be spent on the Port Alberni branch. General Superintendent Beasley announces that from $125,000 to $150,000 will be spent on the line for improvements during the current year.

The plans for the proposed waterworks system for Montreal South, Que., call for the installation of a steel reservoir with a minimum capacity of 100,000 gallons, also a 30 h.p. electric motor-driven turbine pump and 150 h.p. gasoline engine driven turbine pump for fire purposes. Cast iron pipe, lead pipe, hydrants, valves, etc., will be required. The system will cost about $180,000.

Efforts are being made by the Board of Trade of Penticton, B.C., to have the route of the proposed transprovincial highway diverted to pass through that town. The action of the Penticton Board of Trade regarding this diversion is said to have been endorsed by practically every municipal council and board of trade from Kelowna south to Princetown.

Negotiations have been under way between the Hamilton city council and the McClary Manufacturing Company, of London, regarding the transfer of that firm's plant to Hamilton. The chief reason for the contemplated change is the fact that London has no natural gas supply, and the company has been looking around for a location where they will have accommodation in this regard.

Vancouver's building permits during the first two months of the year show a substantial increase over the same period last year. In February there were 36 permits issued at a value of $96,780, as compared with 28, at a value of $79,969, in February, 1916. The total for the first two months of 1917 is 73 permits, valued at $125,825, against 46 permits during the corresponding period in 1916, valued at $88,284.

The building permits issued in Stratford, Ont., during the month of February show a considerable increase over the corresponding month of last year. In February, 1916, there were five permits issued at a total value of only $1,045, while for last month there were four permits valued at $11,305. The additions to the power house largely account for the increased total.

A big jump has been registered in the value of the building permits issued in the city of Montreal during February. The value for that month was $402,565, the permits numbering 55. This compares with $65,915 in the same month last year when an equal number of permits were issued. Up to the end of February this year there were 88 permits issued at a total value of $652,460, as against 99 permits during the corresponding period last year, valued at $240.075.

Following the recommendations recently made in the report of Captain A. V. Delaporte, Acting Provincial Sanitary Engineer, the well at the waterworks plant at St. Catharines, Ont., will be enlarged to enable the electric pumps to be used to their capacity. The drain from the filters is to be carried out to a point in the water 75 feet below the intake pipe, and other improvements made to the plant. Plans are being prepared and the work will be undertaken as quickly as possible.

The formal opening of the new city hall in Orillia, Ont., recently took place. This building has been erected at a cost of $71,000, not including the value of the old walls, which remained standing after the fire of June, 1915. The lower floors contain commodious municipal offices and the council chamber, with market rooms in the rear, while the upper storey will be used as an opera house. The building is largely fireproof in construction and was built from plans prepared by Burke, Horwood & White, of Toronto.

Hon. Finlay G. Macdiarmid, Minister of Public Works for Ontario, recently received a deputation from Addington County with reference to a highway between the villages of Kaladar and Denbigh. The request is that a road be built which will accommodate automobile traffic, as this would give opportunity for opening up the asbestos, mica, graphite and lead mines and the stone and marble quarries in the vicinity. At the present time there is an old colonization road which is kept up by the county grants. The Minister promised to give the matter his consideration.

According to the recent statement of City Engineer Stewardson, no further settlement has occurred in the fill under Columbia street, in New Westminster, B.C., at Albert Crescent, where the old cribwork crossing a ravine at that point is giving way and there had appeared to be the likelihood of a landslide. The engineer's opinion is that the trouble has gone as far as it is likely to do before next winter, before which, of course, the necessary steps will be taken to avert any damage. The provincial government was requested some time ago to make these repairs.

A deputation from Muskoka, Parry Sound and the northern part of Simcoe County, recently interviewed Hon. Finlay Macdiarmid and Hon. G. H. Ferguson at the Parliament Buildings, Toronto, asking for the construction of a colonization road from Orillia to North Bay. It was pointed out that the road would open up a splendid tract of country and would furnish the connection for a highway from Toronto to the "Soo." Though the road was so urgently needed it could not be built, the deputation stated, except by the government taking it over, since the burden would be one entirely too great for the municipalities. Though the Minister made no definite promise, the petitioners were considerably encouraged by the tone of the reply.

Mr. Jos. R. Bell, contractor for the painting work at Park School, Toronto, has applied to the Board of Education for consideration of more pay on account of increased cost of materials and labor since the time the contract was signed. His contract was dated October, 1915, and the work was to be completed in December, 1916. Owing to delays in other work on the building he could not go on with his work and even yet it will take seven or nine months to finish. Meantime, he claims, the cost of material has so increased that $330.22 more is needed, while the difference in the prevailing rate of wages in 1915 and the rate asked by the union in 1917 will amount to $660. He therefore requests that the board provide $990.22 if they wish him to complete the contract. The matter has been referred to the Property Committee.

A report was recently submitted to the council of Etobicoke township, Ont., regarding the Islington, Lambton and Long Branch water schemes, by Mr. Proctor, assistant to Engineer James. He stated that, for Islington and Lambton on a basis of the district served, the plant would cost the citizens 3½ mills per annum for a period of twenty years, and the frontage tax would be 6-8/10 mills per annum for a similar period. The cost of the water used would, of course, be additional. If the water was secured from the city of Toronto it would cost from 20 to 30 cents per thousand gallons, whereas from the local plant the cost would be from 6 to 8 cents. With regard to the Long Branch proposed water system, he said that it would be a much simpler scheme because the water could be brought from New Toronto by the installation of new mains from that municipality. The council favored the local water scheme, which would provide for a flow of 350,000 gallons per day, sufficient to serve a population of about 7,000, but did not commit itself to any definite action.

Personals

Mr. Arthur J. Smith, a well-known building contractor, of Brandon, Man., has enlisted for active service.

Mr. W. Vallance has resigned as assistant municipal engineer of Point Gray, B.C., and will take over the management of a Vancouver garage and repair shop.

Mr. Samuel D. Williams, who has for three years occupied the position of chief division civil engineer for the Michigan Central Railway, with headquarters in St. Thomas, Ont., has been transferred to the company's head office in Detroit.

Lieut. J. R. Cockburn, B.A.Sc., A.M.Can.Soc.C.E., formerly assistant professor of descriptive geometry in the Faculty of Applied Science and Engineering of the University of Toronto, who went overseas with a draft of officers from the 170th Mississauga Battalion and was attached to the 58th Battalion in France, has now been transferred to No. 2 Field Survey Company of the Royal Engineers. This unit is officered by scientists drawn from the universities of the empire.

Obituary

Mr. Thomas S. Wrightman, of New Westminster, B.C., passed away recently at the Royal Columbia Hospital. The late Mr. Wrightman was an engineer by profession, having previously been employed by the Laminated Materials Company, at Sapperton. He had reached the age of 43 years, and was born in Ontario.

Lieut.-Col. Samuel G. Beckett, of Toronto, commander of the 75th Battalion, which went overseas in April, 1916, has been reported killed in action. The colonel was 48 years old and was a son of Edward Beckett, pioneer iron foundry owner. He graduated from Cornell University in Pennsylvania in architecture and formed a partnership with Lieut.-Col. Vaux Chadwick which lasted for twenty years.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Amherstburg, Ont.
The Town Council plans to pave Apsley and Sandwich Streets. Material to be chosen.

Montreal South, Que.
Tenders will be called by the Town Clerk, M. M. Condon, in April for the erection of a $180,000 waterworks. Engineer, E. Drinkwater, 588 Blv. Desaulniers, St. Lambert, Que.

Islington, Ont.
At a recent meeting of the Township Council, James, Louden & Hertzberg submitted a scheme for supplying this area with water. The scheme involves an expenditure of $82,000, including pumps, filters, water tank, and three miles of mains.

Long Branch, Ont.
James, Louden & Hertzberg submitted plans for a waterworks scheme in this district to the Township Council The scheme involves an expenditure of $67,000, and includes meters, standpipe, and five miles of water-mains.

Aurora, Ont.
James, Louden & Hertzberg have submitted a scheme for sewers and sewage disposal plant to the Town Council. The scheme involves an expenditure of $75,000, including sewers, sprinkling filters, sewage ejectors, and force main.

Edmonton, Alta.
The City Council engineer, A. Haddow, is considering sewer extensions, distance about 2,640 feet, probable size of pipe 36 inches.

Moncton, N.B.
The City Council will call tenders for paving streets, to cost $125,000. Bithulithic concrete and bituminous macadam will be laid.

Regina, Sask.
The City Council contemplate laying asphalt or bithulithic paving in the Market Square, to cost $3,000. J. Russell Ellis is engineer.

Simcoe, Ont.
Tenders are being received by the Town Clerk, W. C. McCall, until March 31 for the construction of branch sewers, to cost $7,500. Engineer, Guy Marston, Norfolk St.

Winnipeg, Man.
Tenders will be called in April by the Greater Winnipeg Water District for the construction of cast iron water mains between Red River and McPhillips St. reservoir. Chief engineer, W. G. Chace, 501 Tribune Building.

CONTRACTS AWARDED.

Lindsay, Ont.
Tenders are open until March 15 for the erection of a pumphouse for the Water Commission, City Council, and in connection with which the following contracts have been awarded: Filter and accessories, Norwood Engine Company, Sherbrooke, Que.; turbine pump, DeLaval Company, Peterboro.

St. Hyacinthe, Que.
The Roberts Filter Manufacturing Company, Darby, Pa., have been awarded the general contract by the Waterworks Committee, and will start work April 1 in connection with filter system. Engineer, F. E. Fields, 383 Oxford Ave., Montreal.

St. Lambert, Que.
The following have been awarded contracts by the Town Council in connection with the trunk sewer on Front St.: De Keyeser, Poismans, Cie, 1101 De St. Valier, and E. T. Verbanise, 2069 De Chateaubriano Ave.

Smith's Falls, Ont.
The Town Council, Engineer, S. B. Code, has awarded the general contract for the construction of sewer and water mains, to cost $16,000, to James MacDonald, 20 Mary St.

Railroads, Bridges and Wharves

Moorefield, Ont.
Tenders will be received until March 17 by W. W. Scott for the construction of a 40-foot concrete arch truss bridge on the fourth concession of Maryboro, County of Wellington. Plans etc,, with the engineers, Bowman & Connor, 31 Queen St. W., Toronto.

Toronto, Ont.
Tenders will be received until April 2 by the Toronto Harbor Commissioners for crib work and concrete work for head walls. Plans and specifications at the office of the engineer and manager, E. L. Cousins, 50 Bay Street.

Winnipeg, Man.
Tenders are being received until March 15 for the erection of six houses and four stations for the Canadian Pacific Railway. Plans and specifications with the owners. Architect, J C. Holden, 304 C.P.R. Depot.

CONTRACTS AWARDED.

Gosfield South Township, Ont.
James McGill, caer of Clerk of the Township Council, J. H. Madill, Harrow, has been awarded the general contract for the erection of a $10,000 bridge. Work to start as soon as possible.

Montreal, Que.
The following contracts have been awarded in connection with the erection of a $150,000 station for the Canadian Northern Railway, Dorchester St., by Norcross Brothers, 10 Cathcart Street: Structural steel, F. J. Jago & Co., 37 Mayor St.; reinforced steel, J. P. Dupius, Ltd., 592 Church Ave.; electrical work, Collyer & Brock, 131 St Alexander St.; plumbing and heating, W G. Edge, care of owners; plastering, R. D. Clarke & Sons, Ltd., 26 Lincoln Ave.; painting, E. Mapes, 405 Birks Bldg.; tiles, Smith Marble and Construction Co., Ltd., 145 Van Horne Ave.

St. Eustache, Que.
The Municipal Council, secretary, J. A. G. Belisle, has awarded the substructure contract for a concrete and steel bridge over Chicot River to cost $4,800, to Lagace & Lagace, l'Abarda Plouffe, and the steel contract to the Phoenix Bridge & Iron Works, Ltd., 83 Colborne Street, Montreal.

Unionville, Ont.
Tenders were recently received for a 40-ft. concrete bridge, on plans prepared by James, Louden & Hertzberg, Ltd. The successful bidder was E. Martin, Elmira.

Windsor, Ont.
William Walker, 45 Jeanette Ave., has been awarded the general contract and has started work on the erection of freight sheds, to cost $7,500, for the Canadian Pacific Railway.

Public Buildings Churches, and Schools

Arnprior, Ont.
The Town Council contemplate the erection of a market building. Reeve, Mr. Brennan.

Brome, Que.
The School Board, Secretary, Geo. F. Hall, are contemplating a scheme for the erection of one or more school buildings.

Calgary, Alta.
The Holy Cross Hospital are considering the erection of a $20,000 three-storey addition to their hospital. Architect, Mr. Lushner, care of owners.

Chateauricher, Que.
The School Board, secretary-treasurer, J. C. Methot, are considering the erection of a $4,000 school next year.

Ensleigh, Alta.
Tenders are being received by the secretary-treasurer, D. J. Wilson, until noon March 24 for the erection of a frame school for School District No. 3378. Plans and specifications with the Department of Education or with the secretary-treasurer.

Halifax, N.S.
Tenders are being received by the architect, W. J. Busch, Bedford Row, from March 14 until April 1 for the erection of St. John's Presbyterian Church, to cost $50,000. Plans and specifications with the architect.

Kingston, Ont.
The Kingston General Hospital, Stuart St., are considering improvements, and will appoint an architect to draw plans.

Laurentides, Que.
The School Board are considering the erection of a $30,000 school. Secretary-treasurer, S. Goulet.

Lauzon, Que.
Tenders will be called shortly for the erection of a $50,000, 5-storey, Scotch brick home for Monseignor Chas. Guay, Ville Guay, Levis. Architect, P. Levesque, 115 St. John St., Quebec.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **March 21, 1917** **No. 12**

Principal Contents

Page
Editorial ... 251
Constructional Features of Big Aqueduct ... 253
Mutual Elevator, Fort William ... 256
Organized Industry Essential for Prosperity of Large Cities ... 259
The Work of the Canadian Engineers in France ... 261
The Engineer of the Future ... 262
Fireproof Factory in Hamilton Nearing Completion ... 263
Practical Hints for the Contractor ... 264
National Organization for War ... 266
Electro-Chemical and Metallurgical Possibilities in Canada ... 268
Mainly Constructional ... 270

Co-operation at the Root of Success

THE day when "trade secrets" should be kept secret has passed. In the dim past when business operations were carried out on a different basis from what is to-day considered proper, there was perhaps some excuse for being reticent about divulging trade information. In those days, the business of the world was not carried along on the same plane of efficiency, speed, labor conditions, competition, finance and trade associations, or with the same equipment of machinery or processes as it is nowadays. There was not the same opportunity for deriving profit from association and co-operation and the very crudeness of the work made secrecy of trade details excusable. To-day, however, under the conditions that now apply to the operation of industry, a "for-ourselves-alone" policy does not have as bright or excusable an aspect. Men of affairs are now recognizing that a "get-together" policy has advantages over, and is more effective than, the "for-ourselves-alone" plan. Evidence of this can be seen on every hand in the trade associations, the labor unions, co-operative societies, and even in the commercial combines.

* * *

Though this tendency is becoming predominant and shows signs of becoming the controlling factor in commercial life, still, a very large proportion of the competitive interests still adhere to a secretive attitude. Especially manufacturers and contractors are noted for maintaining this isolation of interests. Such men, we believe, are laboring under the grave misapprehension that co-operation injures business. Perhaps if they do realize the value of getting together, they feel that their own businesses are so different from others or so much better conducted that nothing they do can benefit or should be given out to benefit the other man. How often do we see a contractor use his strongest efforts to withhold from others, his knowledge, his experience and his ideas. He hoards these up that others may not profit by them because he believes that by giving anything away he will be only injuring himself to that extent. Nine times out of ten he turns out to be like the man who thinks that, by giving nothing away, he will get rich by what he takes from others. It works well at first, perhaps, but everybody gets on to the game, and gives him nothing.

Successful contractors and manufacturers are strong for co-operation, because in nearly all cases it has been at the root of their success. The history of all organizations proves that it is the strong men in the trades or industries represented, those who have the most to give away, who most devoutly promote the principles of co-operation, and that the weaklings, who have most to gain and nothing to lose, are the ones who will not participate in trade associations or organizations. If anything is to prove that success comes from co-operation it is the fact that the staunchest firms and men are members of these co-operative bodies—firms and men who have most to fear from giving away their "secrets" to their weaker competitors and thereby giving them an opportunity to reach the same degree of success.

* * *

To refuse to divulge trade information is an acknowledgement of inferiority and weakness, for it is a confession that you cannot keep your position in the face of your competitors. Innumerable instances prove that if you, as a contractor or a manufacturer, are willing to share the things you have learned from experience, you will get more in return than you give. If the other fellow is to use your information to your disadvantage, he must at least have the same organization for applying this knowledge as you, and even if he does, you have a head start. You will find that in spite of having given others the benefits of your experience, you will have a new incentive to improve upon what you have divulged so as to keep ahead of your competitors. It is in this way that new improvements are produced. Have no trade secrets but bring what you know to a common council; you will not feel impoverished, you will be enriched.

All this means that co-operation, organization or association, as you care to call it, is a necessary factor in modern business or professional life. That it leads to success is seen in the benefits that accrue from such powerful trade associations as, for example, the Portland Cement Association. Every cement manufacturer, jobber, dealer, contractor and user has been the gainer by the work of this body. Essentially this association is nothing more or less than a common council of the cement industries where trade information is pooled and disseminated for the mutual benefit of whoever cares to use it. This particular instance is but typical of the many trade associations that are to be found on the other side of the line. Canadians are slower, perhaps, to reap the rich harvest that follows co-operation of this kind, but trade demands it and it is just a question of time before its principles will be universally accepted. Manufacturers, dealers, builders, in the hundreds, are working under disadvantages because they still stick to the petty idea of concealment and mystery regarding their trade affairs.

Good Roads Influence Spreading

OVER one hundred delegates from all parts of the province attended a convention of the Nova Scotia Good Roads Association recently held at Halifax. This association was formed in September, and the executive have since been engaged in drawing up a plan for improving the main roads of the province. At the suggestion of the executive, the meeting passed a series of resolutions in favor of radically changing the present system of maintaining and improving the public highways. The meeting suggested the appointment of an independent commission with full authority to delineate, maintain, control, and improve the highways. The monies required should be raised by means of an annual road tax of 50 cents on the $100 on the value of all property adjacent to the main highway; by the payment by the Provincial Government of a sum equal to that received from the road tax; and by contributions from cities and towns.

It was further resolved that in the case of any municipality desiring any permanent improvement, it should notify the commission, which should at once proceed with the work, having regard to the materials available and the necessity of the traffic as might seem to it best adapted for the purpose. The cost of this improvement is to be borne by the province, bonds being issued for that purpose; on completion of the work an account is to be rendered to the council, which will assess upon the municipality a sum to be fixed by the Commission equal to one-third of the interest and sinking fund required to redeem the bonds at maturity, this sum to be paid over to the provincial treasurer annually. One-third of the interest and sinking fund is to be paid by the province out of funds collected as license and registration fees on automobiles, and the remaining one-third is to be contributed out of the ordinary revenues of the province. The highways so improved are to be maintained by the Commission. The Association voted in favor of the abolition of highway labor and the substitution of a tax in cash.

The various points in these recommendations were discussed in detail, and while there were criticisms on minor points, it was generally agreed that the recommendations were on the right lines. The need of educating public opinion as to the real economy of good roads was emphasized, but it was also pointed out that the people of the province could not get better roads without paying for them.

In accordance with a resolution asking the government to initiate legislation to carry out the recommendation, a deputation waited upon the Premier, who was presented with a tag with the slogan "We want good roads, and we're willing to pay for them." It was represented to the Premier that there was a great opportunity to improve the roads.

The Premier replied that the matter of finance was the chief difficulty of the government. He pointed out the obstacles to the province going into the financial markets and securing money under present conditions, but said the government would be pleased to co-operate by aiding from ordinary revenue if opportunity arose.

The following officers of the association were elected: President, Mr. G. Fred Pearson, Halifax; first vice-president, Major W. H. Roach, Windsor; second vice-president, Mr. J. S. Whyte, Glace Bay; third vice-president, Mr. W. Churchill, Brooklyn; secretary-treasurer, Mr. Ralph P. Bell, Halifax. A committee representing the various parts of the province was also elected.

True Patriots

OUR New York contemporary, Engineering Record, editorially commends the patriotism of the Canadian engineering profession, which has not been lax in giving up its members for the cause for which we are fighting. The Engineering Record's comment follows:—

"Foreign papers bring the news of the human toll that the war is taking from the engineering profession. The English papers tell the story in almost each issue, as did the German technical periodicals during the time when they were still coming. In Canada, likewise, the war is exacting its price. Twenty-four percent. of the membership of the Canadian Society of Civil Engineers (which has 3,200 members) has enlisted and 34 of them have been killed. Surprisingly, too, the majority of those who have enlisted are not juniors. The associate members in khaki outnumber the junior enlistment 2 to 1. In a word, the engineers of Canada are true patriots. In the great trial to which the Empire is being subjected, they are willingly bearing their part."

A Big Turn-out Wanted

The first annual report of the Joint Committee of Technical Organizations will be presented at a general meeting of engineers and technical men of the province, to be held in the Chemistry and Mining Building of the University of Toronto, on the evening of Friday, March 30, at 8 p.m. A large attendance is requested, as this will be the first opportunity for a general discussion of the activities and the future plans of this organization. Especially it is hoped that helpful and constructive suggestions will be forthcoming. Among other prominent engineers who will be present and address the meeting there will be John Murphy, Ottawa, R. A. Ross, Montreal, and E. P. Mathewson, Toronto.

Irish & Maulson, insurance brokers, Montreal, advise that on and after Thursday, March 15th, their address will be Nos. 801-2 Bank of Toronto Building, corner of McGill and St. James Streets, Montreal. Their telephone numbers, Main 7237 and 7238, remain as before.

Constructional Details of Big Aqueduct

Third Article of the Series Describes Excavation and Backfill Methods on Contracts 30 and 31—Almost Exclusive Use of Specialized Machinery

By Charles J. Bruce*

THIS article is the third of a series of six dealing with the construction of the 85-mile concrete aqueduct of the Greater Winnipeg Water Supply. The first article, which appeared on February 28, described the general features of the work; the second, which appeared on March 7, described the contractors' organization, while this article sets forth the excavation and backfill methods on Contracts 30 and 31 (the two westerly sections of the aqueduct). This article may well be read in conjunction with the fourth one, by A. C. D. Blanchard, Division Engineer, which deals with the excavation and backfill methods in Contracts 32, 33 and 34, and which will appear in next week's issue.

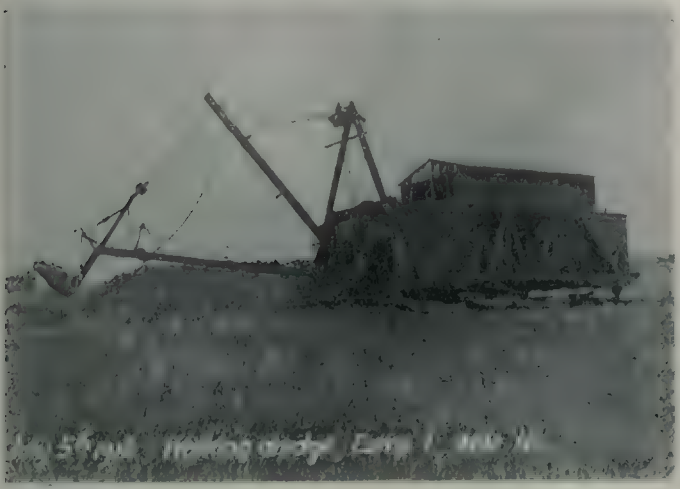

Fig. 1 -Walking dredge used on contract 30. Note scraper-like bucket.

The excavation on Contracts 30 and 31 varies from a cut of one foot at mile 22 on Contract 30, to 18 feet at mile 34, on Contract 31. Contract 30, called the prairie section, extends from mile 13 to 33, and Contract 31 from mile 33 to 51, the railroad mileage being used, and signifying roughly, the distance from the terminal reservoir in Winnipeg. The total excavation yardage on Contract 30 is some 311,000 cubic yards, and on Contract 31, some 300,000 yards. The general plan of excavation followed on the whole work is the removal of the earth to within six inches of the bottom of the trench by machines of various types, and the hand trimming of the remainder to the exact payment lines just before placing the concrete for the aqueduct floor. There are three camps on each contract, no two have exactly similar conditions as to soil, drainage or aqueduct section, so each camp will be treated separately.

Excavation by Walking Dredge

The first section on Contract 30 extends from mile 13 to 17. The average cut is 9 feet and the width of the trench bottom on the payment lines is 10.6 feet. All side slopes of trench excavation on both contracts are one foot horizontal to three feet vertical. The digging machine used on this contract is a "walking dredge," so-called, although this is a misnomer. This machine is really a gasoline shovel with a walking attachment. The carrying frame is 26 x 35 feet. On either side are three feet or wooden paws, the end two of which act together. While the machine is supported on the outside paws, the middle one is lifted and slides along the frame until it reaches the front paw. Then it is lowered to the ground and acts as a support for the entire machine, while the two end paws slide along the ground the length of their step. Then the operation is repeated. In the accompanying photograph, the machine is shown resting on the two pairs of end paws, and the middle ones are about to be lowered to the ground to support the machine. This walking dredge can "walk" about a mile in ten hours; under good conditions it can move 1,500 yards of earth in the same time.

The maximum cut for the machine shown in the accompanying photograph is 16 feet, and the extreme width of the top of the trench which it can take out is 22 feet. When the excavation is done, the machine is turned around by tying down the feet on one side, while the feet on the other walk around them, and it then walks back to the beginning of the uncovered concrete pipe. All the excavated earth is placed on one side of the trench, as the other is left at the undisturbed ground level, that the concrete mixers may travel along the edge of the trench. In backfilling operations the walking dredge eats its way through the earth pile and placing it on top of the pipe solemnly waddles on to the end of the excavated material, there to resume its former duties of excavating. The motive power is a 50 h.p. gasoline engine. The 1-cubic yard shovel is under perfect control, and the machine can take out a ditch to within the nearest tenth of a foot of grade.

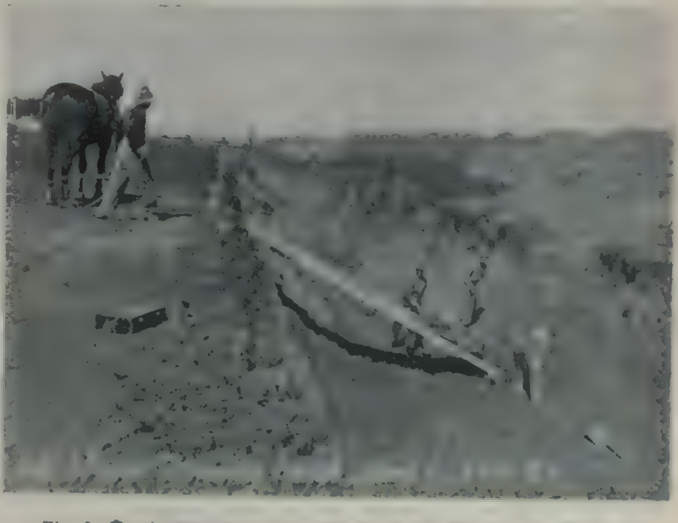

Fig. 2—Hand trimming trench with horse and slip scraper. Note that scraper is used for the removal of materials trimmed by hand.

Bottom of Trench Hand Trimmed

Owing to the concave shape of the bottom of the trench for the reception of the invert of aqueduct on the District's work, and to the importance of keeping the bottom from softening by water lying on it or from cracking by exposure to the sun, at least six inches of earth is left by the digging machine and hand trimmed immediately before the placing of the concrete. Figures 2 and 3 show this operation. In Fig. 2 the method of taking this hand-trimmed earth from the trench is shown. The contractor has an ordinary scraper working on a timber slide, which is pulled out of the trench by a horse. Fig. 3 shows the trimmed bottom of the trench with the invert "profiles" or end forms set for the reception of concrete.

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* Division Engineer.

The first four feet of backfill above the bottom of the trench work is solidly packed before the machine places the remainder of the earth covering. On Camp No. 1 this packed backfilling is placed in 6-inch layers tamped by hand. The specifications call for a depth of 6 feet of consolidated earth on top of the aqueduct on camp 1, so the contractor is placing 7.5 feet of loose earth, which he estimates to be sufficient to take care of all settlement.

The trench excavation at Camp No. 2, Contract 30, is to receive the largest section of aqueduct on Contracts 30 or 31, viz.: 7 ft. 4⅝ in. high by 8 ft. 9 in. wide, inside measurement, and extends from mile 17 to mile 23.4. The trench is 14 ft. 8 ins. wide at the bottom. The cut is shallow, ranging from 1 foot to 4 feet 6 inches. The excavation at this camp is being taken out by a smaller walking dredge than that described above, the one in use at Camp No. 1. All the excavation is placed on the north side of the trench, and the concrete mixers work on the south side. On account of the shallow cut at this camp the walking dredge is able to excavate faster than concrete can be placed. This enables the machine to return to place the backfilling material on the aqueduct. The quantities from excavation are not sufficient to complete the backfill, which must be four feet deep on top of the aqueduct after consolidation, so the balance is placed with a dragline, borrowing on the south side of the trench. The packed backfill at this camp is placed with horses and scrapers and this tamps it into a solid unyielding mass. Fig. 4 shows this method. Each team travels 90 feet along the pipe for every scraper full of earth which is dumped, walking upon the material previously so placed, so that the very best results are obtained. Fig. 5 shows the packed backfill in place ready for the machine to complete it.

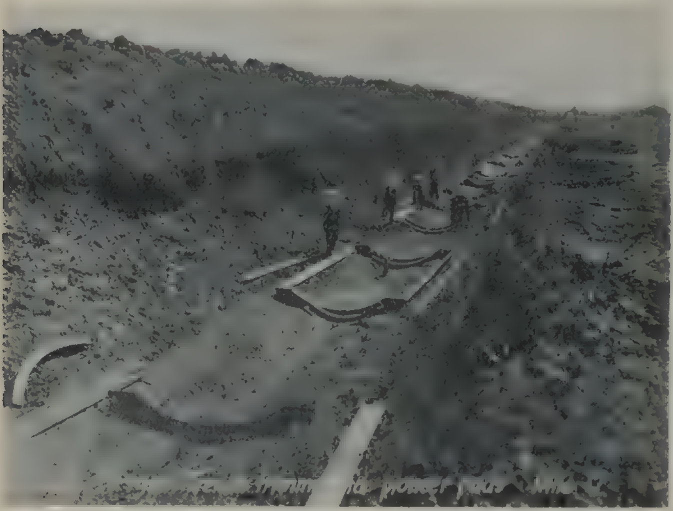

Fig. 3—Trench trimmed for pioneer pads at Mile 17.

Extra Backfill to Take Care of Settlement

The contractors on Camp No. 2 are placing two extra feet of earth on top of the aqueduct to take care of the settlement here. This amount is probably in excess of the required quantity, but the contractor prefers to place more than the exact quantity necessary rather than to run the risk of having to go over the work again. The shrinkage at this camp will be more than at any other, owing to the height of the backfill above the ground level on account of the shallowness of the cut and the size of the aqueduct.

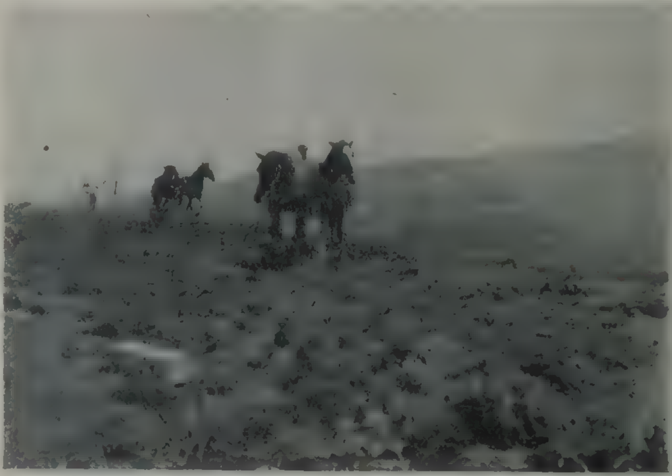

Fig. 4—Placing packed backfill at Mile 21 with scrapers and teams.

The aqueduct being built at Camp No. 3 is on the steepest slope encountered anywhere on the eighty-five mile profile, viz.: 1,537 feet per 1,000; consequently it is the smallest in interior section, 5 ft. 4¾ ins. high by 6 ft. 4¾ ins. wide. The trench is 11.8 feet wide at the bottom. This contract section extends from mile 23.4 to mile 32.6, 9.2 miles.

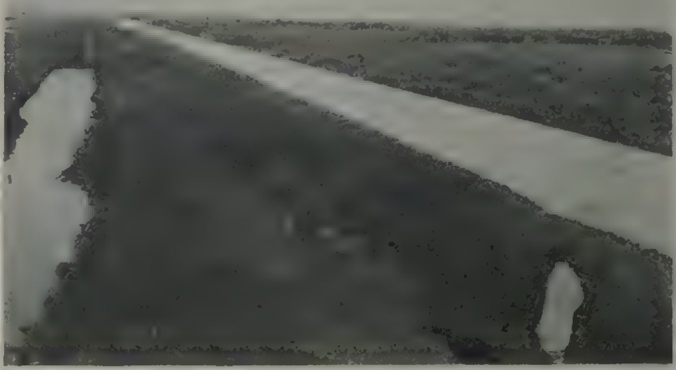

Fig. 5—Arch section of the concrete aqueduct with packed backfill in place, Mile 23.

The method of excavation and backfill used here is similar to that on Camp No. 1, a walking dredge being used. The packed backfill is placed by hand and is tamped by leading horses over it, as shown in the accompanying photo, Fig. 6.

Camp No. 3 is the only opening on Contract 30 which has been troubled with water in the trench. All concrete must be laid in the dry on this work.

The general practice is to lay a wooden box drain, inside measurement 6 in. by 6 in., two inches below the grade of the trench. This drain is packed around with coarse gravel, and carries the ground water to a sump outside the trench, whence it is pumped into surface drains by pumps of varying size, according to the waterflow.

Shovel on Rails Spans Trench

The excavating and backfilling equipment of the contractor on Contract 31 differs radically from that in use on Contract 30, the ubiquitous dragline being the only machine common to both jobs. As on the prairie section, there are three openings, each building a different sized aqueduct. Camp No. 1 takes care of the aqueduct from mile 32.6 to mile 39.4. The aqueduct here is 8 ft. 3¾ ins. wide by 7 ft. high, inside measurement, and the bottom width of the trenches is 14.1 feet. For excavation on this work the contractor has used hitherto ⅝-yard Thew automatic shovels and a dragline. The material to be excavated here is very different from that on the prairie section. There it is almost wholly loam and clay, with very few stones. On this opening, however, there is a thin layer of loam above gravelly pan. The maximum cut here during 1916 was 18 feet. The dragline takes the first seven feet, as shown in Fig. 7. A shovel, operating on the floor of the trench takes out another seven feet, and the second shovel, mounted on a framework which spanned the trench and run on rails on either side, excavates to grade. This arrangement is shown in Figures 8 and 9. Fig. 8 shows the two steam shovels, one mounted on the framework spanning the trench, and the other in the trench itself. Fig. 9 shows the upper shovel in difficulties owing to the boulder clay in which it is working.

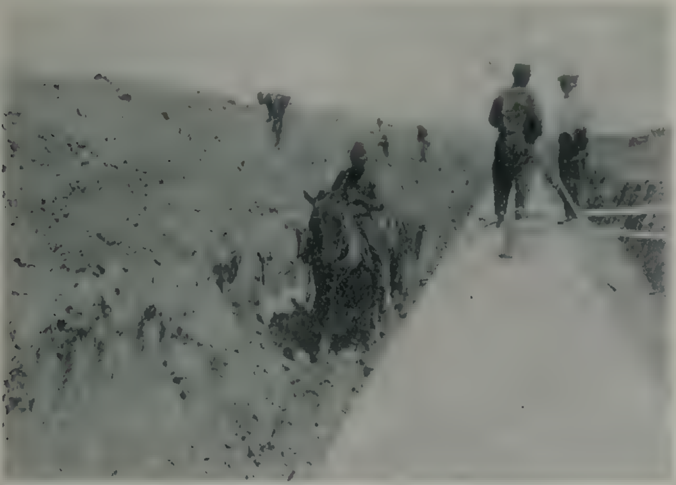

Fig. 6 –Packing the hand placed backfill by horses. Four feet of this backfill is placed at haunches of the arches before the machine-placed backfill is put over the aqueduct.

At Camp No. 2, the aqueduct crosses the valley of the Brokenhead River in a depressed siphon 14,000 feet long. The pipe is circular, 7 ft. 6 ins. inside diameter, of reinforced concrete. When construction began three years ago, the Brokenhead was a sluggish stream about fifty feet wide and eight feet deep at the crossing of the aqueduct centre line, meandering slowly through a wide marshy intervale. Two years ago, the District dredged a straight course through the marshes for three miles below the aqueduct crossing. This transformed the erstwhile eight-foot river into a brook a few feet across, and this winter the contractor working at the crossing cannot get enough water to supply his steam shovel, and has been forced to drill a well at that point. This lack of water is not all due to drainage. All the surface water in the swamps has been sealed by frost. The work on either side of the river at this camp has been done by teams and hand work, but in the river bed, the contractor is using one of his ⅝-yard shovels. The material throughout this opening is a firm grey clay, underlying one or two feet of black loam or peat. The maximum cut is fourteen feet. At this opening the contractors were troubled much with surface water in the excavation, and constantly used a battery of 2½ in. submerged centrifugal and double diaphragm pumps. At some points the surface water drainage into the excavation exceeded 10,000 gallons an hour.

Surface Water Gives Trouble

At Camp No. 3 has hitherto been the most easterly opening of Contract 31, and this comprises the aqueduct between miles 42.1 and 50.3, 8.2 miles. The maximum cut here is 8.5 feet. The concrete structure here is 6 ft. 2¼ ins. by 7 ft. 4 ins. wide, and the trench is 13 feet wide on the bottom. The material excavated here is 2 to 3 feet of peat overlying yellow clay. Surface water is more troublesome than at any other camp on Contract 30 or 31, and is cared for by a variety of pumps, 4 in. centrifugal, 2½ in. submerged

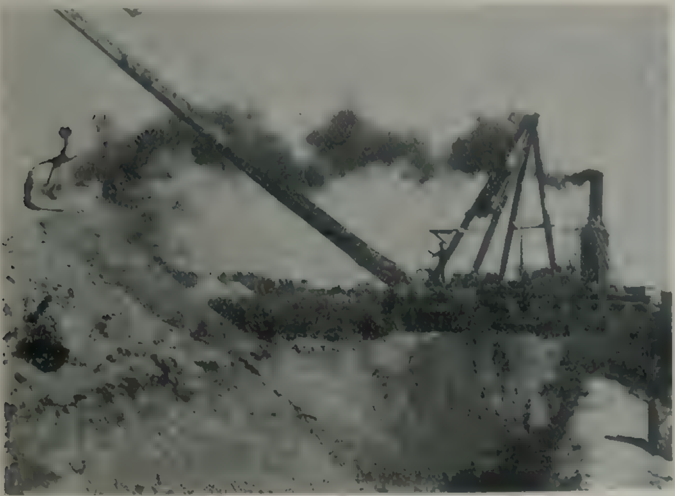

Fig. 7—Drag-line excavating first seven feet of 18-foot cut at Camp 1, Division 31.

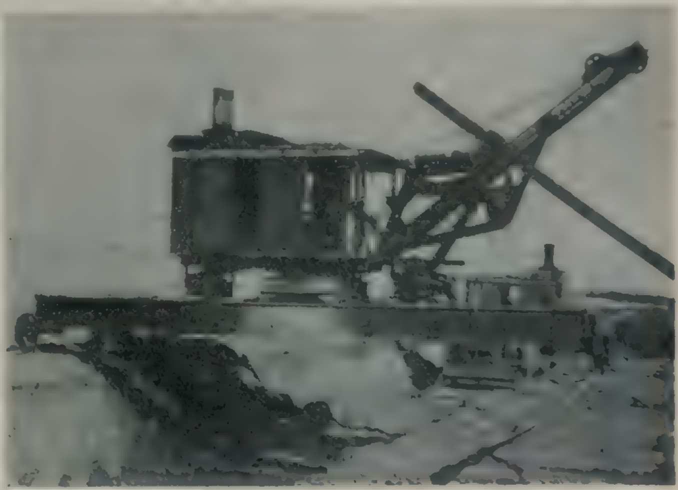

Fig. 8—Five-eighth yard Thew shovels excavating in tandem in 18-foot cut, Camp 1, Division 31.

centrifugal pumps, double diaphragm pumps having a capacity of 3,500 gals. per hour, and single diaphragm pumps of half this capacity. All pumps on this work, with the exception of the 4-in. centrifugal, which is steam driven, use gasoline engines as their motive power. The excavating machine at this camp is a ⅝-yd. Thew automatic shovel. Some backfill work was done by a home-made dragline, converted into such from a stiff-leg derrick used the previous year to handle the concrete aggregate. In addition to this an Ohio clam shell on a Browning crane was used for the same purpose.

Over a mile of the 1916 work on this camp lay across a large marsh, where the grade of the bottom of the trench lay in material which did not give a sufficiently firm foundation. In order to furnish a good bearing surface, this was excavated below grade, and refilled with fine gravel thrown into water at a height of two feet above grade. The water was drawn off downward and the foundation fill excavated by hand to grade. This method gives a first class bearing surface, the gravel being so compacted by the passage of the water through it, as to make it necessary to use a pick when excavating it.

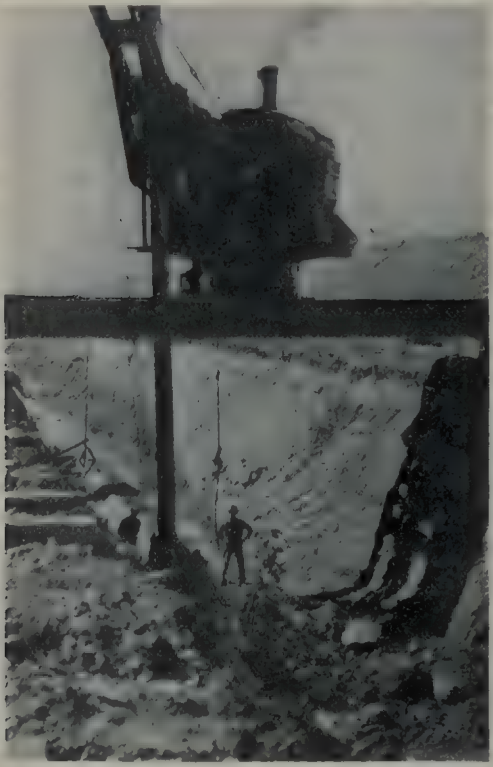

Fig. 9—Five-eighth cu. yard Thew shovel in difficult boulder clay at Camp 1, Division 31.

Owing to various delays on Contract 31 during the seasons of 1915 and 1916, the contractors are far behind the schedule of progress, so in 1917 they are putting in two new camps. This will nearly double their equipment at present on the job, and will be sufficient to permit the finishing of their work by the end of August, 1918, which is the date set for the completion of the aqueduct.

Mr. R. O. Wynne-Roberts has been appointed consulting engineer to the Water and Light Commissioners of Sault Ste. Marie to report on several water schemes for that city. The first installment will be about 5,000,000 gallons per day.

Mutual Elevator, Ft. William

Capacity 500,000 Bushels — Tallest Existing Working-house of its Kind — Special Methods of Building Storage Bins

THE first problem confronting a company desirous of building a grain elevator is the question of location, assuming that their finance and arrangement for a feeding connection or source of supply for the elevator have been satisfactorily worked out. It is highly important that such a position be secured, that overhead charges may be cut to a minimum, for the grain business is very competitive, and an elevator company making their plans for a successful venture do not dare assume any voluntary handicap. If it is decided to build at the head of the lakes and engage in either private grain merchandising or terminal elevator business, a site on the waterfront is imperative. A house built inland can ship east only by car or else pay toll to a competitor for transfer to boats and to the railroad for switching. For even a small private business these two items will amount to from $15,000 to $25,000 a year. Capitalizing this charge makes any water-front site cheap as compared to an interior location.

Selection of Site

At the head of the lakes the selection of a site also depends on which railway the operator wishes to use, and this, in turn, depends on his business programme. Our largest elevators are built in such locations that they are served by one railroad only, but these elevators are terminals, and were designed to serve the grain trade originating on the respective railroads.

The Mutual Elevator Company, having in mind these things, selected a site served by an industrial spur which connects with all three Canadian railways free of switching charges, and their property fronts on the Kaministiquia River for dockage and shipment by lake steamers.

The plant was designed to receive, clean, dry, store, or ship grain by cars or boats. It is a thoroughly up to date, fast-handling elevator, designed for a private grain business, but could easily be converted for terminal business.

The elevation of base of rail is approximately 40 feet above the river. Work house and storage have pile foundations and foundation mattresses of reinforced concrete over the whole area. The piles were not driven to rock, as that depth is beyond the length of timber in the district and the driving equipment, but so carefully were the pile loads computed and the piles spaced that there is not a hairline check from settlement, and the plant has been loaded to capacity and emptied several times.

Wood Used in Construction

The working house, 42 ft. x 56 ft. in plan by 172 ft. high, is built of wood, covered with corrugated galvanized iron, and is the tallest house of that type in existence. It is, however, so carefully designed and erected and so fully stayed and braced that it has all the rigidity of a fireproof house, and, due to its exceptional height, has great flexibility of operation. Wood was chosen for a building medium only to save time of construction.

Cars are received over four tracks, and there is a fifth track as part of the system for the expeditious handling of empties. Thirty loads may be placed at one time, and are unloaded by four automatic power shovels into four pits, each of carload capacity. The four pits discharge their grain to a 36-in. conveyor belt, carrying grain to the receiving elevator leg. Each pit is closed by a valve over the belt, and this valve-operating lever is part of an ingenious contrivance which allows only one valve to open at a time, and so automatically and positively prevents the mixing of grain in the process of receiving. The receiving leg, capable of handling grain at the rate of 15,000 bushels per hour, may also be used as a shipping leg. It lifts its grain 170 ft. and discharges to a 2,000 bushel garner over a 1,600 bushel scale. The scale is of the latest improved type and very sensitive. The scale beam and counterpoise is "type registering"; the weight of each draft is mechanically registered on a ticket, which is checked by two men (one a government inspector), so that chance of error is practically eliminated. The grain, having been weighed, is discharged from the scale hopper to any bin in the work house direct without transfer. There are 50 bins in the work house, each of 2,000 bushel or more capacity. It may, however, be sent to any bin in the storage (described below), if desired, or it may be shipped direct to boat or by cars or spouted to the dryer bins.

THE MUTUAL ELEVATOR CO., LTD.
FORT WILLIAM, ONT. - WINNIPEG, MAN.
DATE FEBRUARY 13, 1917

A 500,000 bushel grain elevator at Fort William, Ont.

Work House Machinery

In the first storey of the work house are four No. 10 Monitor receiving separators. These are driven by individual motors in batteries of two, and are served by the work house bins over them. These cleaning machines discharge their cleaned grain to cleaner legs, one for each battery, their screenings to a screenings leg, and oats off of each battery is collected in a bin in the basement below. At the end of a run the oats may be discharged to the shipping legs and sent to the oats bin. In the cupola on the distributing floor is a No. 7 48-in. Richardson cleaning machine for fine work on wheat and oats separation, and a No. 5 Fosston separator for special cleaning. Each of these machines is served by a garner above the machine, and each is separately driven by motor.

In addition to the legs mentioned above there are two large shippers, each capable of elevating 15,000 bushels per hour under average operating conditions. There is only one size of bucket used throughout the plant, 7½ x 7½ x 14 in. Rialto pattern; this does away with the necessity of stocking great numbers and sizes for purposes of repairs. There are two lines of buckets on the receiving and shipping legs and one line on the cleaning and screenings legs. An elevating rate of 20,000 bushels per hour has been maintained for short periods on the shipping legs. The cleaning legs discharge their grain to either a telescope spout for distribution or to a shipping scale if it is desired to ship direct from cleaners. All leg drives are individual motors to countershaft by Morse silent chain drives and from countershaft to head by rope. Steel plate clutches of stand-still type are provided on these countershafts to assist in pulling the leg through the choke.

Storage House

The storage house is located between the work house and the river. It is absolutely fireproof, and is shut off effectively from the work house by fire doors. It consists of sixteen circular tanks 86 ft. high by 20 ft. in diameter, nine interstice bins and three shipping bins, the storage having a total capacity of over 400,000 bushels. Storage tanks were built by moving forms operated by jacks of a new and efficient design developed by the contractors (patents applied for). The pouring of the tank walls was a continuous operation from start to finish, an average raise of 6 ft. per day being made. The smooth, dense, tank walls resulting from this improved method well repay the small additional trouble and expense.

There are three belts under the storage and three over the tanks, in a concrete cupola. Each belt in the cupola extends to the work house bin floor over a steel conveyor bridge, and each has a self-propelling, two-pulley, two-way tripper of up-to-date design, and heavy enough to stay where it is clamped.

Shipping to boat is done over three belts to three boat-loading spouts. Grain to be shipped may be weighed up a few hours ahead in any bin in the storage and shipped to boats by reversing the direction of the belts under the storage, which deliver their grain, under these conditions, to the three belts to the boat spouts. The more usual course, however, is to ship direct from the scales to boat, over the cupola belts, into the three special shipping bins, which, in turn, feed the belts to boats.

Dryer Plant Under Construction

A modern, fireproof dryer plant is under construction. This plant will extract 5 per cent. of excess moisture from 250 bushels of grain per hour. Grain may be sent direct to dryer from the receiving leg, the two garners for the dryer having a capacity of one car each. From this point the dryer plant handles its grain independent of the work house, the dried grain being elevated by a special leg and put over work house cleaners or sent to storage. Steam for the dryer coils is generated by a 55 h.p. boiler, and the designers have paid particular attention to the laying out of the steam lines and the introduction of the proper steam specialties to make this part of the plant economical and free from the trouble which so often develops in connection with dryer plans constructed under indifferent supervision.

Power for the elevator plant is received at 25,000 volts and transformed to 550 volts for power and 220 for lights. The Mutual Elevator Company have their own fireproof sub-station house and equipment of transformers, switchboards, meters, syncronous condenser, etc., all tending to perfect their power conditions, and forms a worthy unit in the elevator, the whole a consistent and well-developed plant.

Work Finished to Schedule

Work was actually started in the field by the contractors—Fegles-Bellows Engineering Company, Ltd. —about April 1, 1916, and, regardless of most adverse commercial conditions in Canada, the contractors were able to redeem their promise to the owners and take in grain according to schedule, Sept. 15, 1916.

We are indebted for this description of the Mutual Elevator to Mr. G. R. Duncan, of G. R. Duncan & Co., real estate dealers, who specialize on industrial property.

Beatty Brothers, Fergus, Ont., have issued a very valuable booklet giving directions for making a model stable with BT equipment. The illustrations and drawings are particularly clear and detailed, and the instructions are very complete. General directions are given for carrying on every part of the work. This firm also manufacture fittings of every kind for the barn and stable, as well as a great variety of tools and machinery required around the grain or dairy farm.

A System of Provincial Highways Provided in New Ontario Act

A BILL has been introduced in the Ontario Legislature by Hon. Finlay Macdiarmid, Minister of Public Works, providing for a system of provincial highways from the southwest boundary of Ontario to the boundary line between Ontario and Quebec. The roads assumed by the province, under this legislation, shall be under the control of the Department of Public Highways. They are first to be designated by the Lieutenant-Governor in Council, after which the Minister of Public Works and Highways may deposit a plan in the proper registry office and give notice of the date upon which the roads will pass to the control of the department. In rural districts the municipalities will pay 30 per cent. of the cost and maintenance and the provincial government 70 per cent. In areas adjacent to the cities, designated as "Provincial suburban," the city and local municipalities will pay 30 per cent. each and the government will assume the remaining 40 per cent. The department will transmit annually to each municipality a statement showing the expenditure and the amount due by each municipality to the province, which shall be payable to the province within six months from the date of notification. In certain cases where the work is continuous between municipalities or is on the boundary line, the expenditure may be apportioned by the engineer of the department. In the case of bridges having a clear span of twenty feet or more, the municipality will be required to pay 60 per cent. of that part of the cost of construction or improvement which would have been expended by the municipal corporation for local purposes, the remainder to be borne by the province. After construction, the maintenance of the bridge will be in the same proportion as the remainder of the highway. Provision is made for various details such as electric or street railways, trees growing on the highway; the location of fences and buildings; telephone, telegraph and electric light or power lines; the survey of roads; the construction of sidewalks by interested municipalities; and the regulation of traffic. Any point of dispute as to assessment shall be referred to the Ontario Railway and Municipal Board.

Conditions at the Front

Major T. E. Powers, O.C. Signal Training Depot, addressed the Ottawa Branch of the Canadian Society of Civil Engineers on March 9 in the Drill Hall, No. 3 Field Company's quarters. The subject of the address was, "Conditions at the Front, with Special Reference to Front Line Communications." Major J. A. McKenna, O.C. Third Field Company, welcomed the guests.

Ottawa Branch, C. S. C. E.

The Ottawa Branch of the Canadian Society of Civil Engineers held the second meeting of the year on March 15 in the Carnegie Library. The speaker was Mr. C. R. Coultee, engineer-in-charge, Ottawa River Storage, who spoke on Ottawa and St. Lawrence River regulation, discussing the regulation and concentration of their rapids into abrupt falls for power purposes.

Organized Industry Essential for Prosperity of Large Cities

By J. Ainey*

PERMIT me, before proceeding, to congratulate this Builders' Exchange for its perseverance in keeping alive an organization of master builders and dealers in building material all through the depression caused by the war; and you deserve the more praise considering that this stagnation in business was aggravated by following a building and real estate boom, which always works disastrously on any community.

As the title of my remarks suggests, and in answer to your kind invitation, I desire to avail myself of this opportunity of speaking of matters bearing on the organization of men engaged in different industries.

My remarks will, I believe, show that a community cannot thrive on this continent without organization, both from a continental and from an economic point of view; and, further, I wish to make a few remarks on the influence organization, or the lack of it, has on the municipal life of a city.

I take it for granted that you will admit, with me, Montreal is not a banner city as far as organization is concerned. I concede business men are organized. We have our Board of Trade, Chamber of Commerce, Manufacturers' Association, Builders' Exchange, etc. The missing link in our chain of organization is the worker. Our laboring men have not, as in other cities, formed permanent associations of well-informed, energetic members, whose collective effort tends to make the labor movement a factor for good in all the different phases of modern municipal life.

Although our labor movement is not what it should be, considering the importance of our metropolis as a financial and industrial centre, it would be a serious injustice if no mention were made of the part taken in the last five years by the Trades and Labor Council of Montreal and its affiliated unions in securing provincial legislation tending to ameliorate the conditions of the toilers and in its co-operation with other public bodies in all the attempts that have been made to improve our municipal government. But how much could be accomplished if all the workers in our principal industries were organized in well-directed associations, where employers and employees would work harmoniously to make our city retain its supremacy as a real metropolis in all its activities? We certainly would not notice, as we do now, and have for the last five years, contracts for the erection of first-class buildings given to American firms. Why should men from the United States come here and be permitted to capture work that should be executed by home talent?

The explanation of this state of affairs lies in the fact that our wealthy neighbors to the south of us have attracted by different business methods the sturdy sons of Canada and other countries to their cities and towns, by offering better conditions of work, under the form of better pay and shorter working days. This is the main reason for Canada losing hundreds of thousands of her sons from the rural districts, as well as from the large centres of population.

We not only lose our own young Canadians, but the immigrants brought here at some expense by the government leave us to become citizens of the American republic.

It is not the purpose of my remarks to dwell on these causes. I wish to speak of the local conditions only. I will, however, risk this opinion: It is a fallacy to attempt to develop a new country like Canada on cheap labor, when our powerful American competitors follow the opposite policy, and so attract the best mechanics of all countries.

I have stated that, from a continental point of view, it was impossible for a city to prosper unless industries were organized. What I mean is this, and in the first place I limit my observations to Montreal and the Continent of North America. The cost of living is as high in Montreal as in any large city in Canada or in the United States. I will say figures compiled by a member of Parliament of Canada prove that it costs less to live in Boston or Chicago than in Montreal. This is easily explained. Commodities are controlled by trusts and combines, whose influence and power extend all over the two countries. We have a few Canadian aggregations of business men who have a complete control over certain products. Canadian consumers pay as high a price for these goods as our American friends, for the simple reason that our protective tariff excludes some American products from coming into this country, and our manufacturers of the same products can, therefore, make very substantial profits.

I make this statement to demonstrate that my contention is correct. The cost of living here is on the same level as in the United States.

What is the average income of Montreal workingmen, who form 80 per cent. of the consuming public? A statement including figures is not necessary. As employers of labor, you are familiar with the wages paid, and I presume you will not dispute the fact that wages are lower in this city than in any other city on this continent. This can be verified by consulting the list published annually by E. M. Craig, secretary of the Builders' Association, Chicago. A mere glance at those figures will convince one immediately.

Considering the severity of our climate and consequent result on the cost of the necessities of life, the wages here should be higher. We need better and more substantial food; better housing and clothing. The fuel and lighting items in the bill of expenditures of a Montreal home are also at top figures.

What are the effects of this situation on the character of our people? In this age of easy and rapid transportation and communication distances are suppressed; the eight-hour day and five, six, or seven dollars a day is just as well appreciated on St. Catherine Street as in New York or San Francisco. It has a disparaging effect on the morale of these men. That great mover of men, the incentive of gain, is obliterated. Why exert ourselves, say the workers? We get nothing for it; our earnings will not be increased. If we improve our system of production we are not rewarded. No collective bargaining; it is every one for himself, and we are left to be the victims of this pitiless law of supply and demand. If this law of supply and demand were applied universally there would be no resentment on the part of the toilers, but its application is one-sided. For competitors the workers of Montreal have every nation of the earth. The federal and provincial governments, transportation companies, church societies, all combine in flooding our labor market. Elaborate, original advertisements are published in European countries booming the great advantages of Canada, and, as a consequence, the Canadian worker, as a wage earner, has to compete against the world, while our industries are protected by a well-nigh prohibitive tariff.

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* Montreal Controller, before Montreal Builders' Exchange.

These are some of the reflections I have often heard uttered by men in the building trades.

Another evil resulting from this state of affairs is the loss of our young men who leave our city after learning a trade. This is an irreparable loss to our country. Many young men I have known are now citizens of the United States. They should be with us. In a trip through the Eastern States I was astounded at the number of people who admitted they were Canadian-born of French and English descent, attracted thither by superior working conditions.

I have attempted to give you a description of the status of Montreal workingmen and their grievances. Now, what influence has this policy of low wages on the life of our community?

I will not analyze extensively the effects of this absence of regulations between employers and employees on the social status of our population. But I must mention the fact that Montreal has the unenviable record of being the city where, statistics prove, infantile mortality is the highest. It is true, some improvement has taken place in the last few years, thanks to the efforts of our municipal hygiene department and voluntary associations of ladies and gentlemen, who have accomplished much to lessen this evil by distributing free of charge pure milk to families too poor to purchase it themselves. The establishment of milk stations has my approval. The people who devote their time and energy to this work deserve the gratitude of all well-thinking people, especially for the educational feature of their work. It is nevertheless only a palliative. The root of the evil is insufficient revenue for the beneficiaries of these institutions.

To a great extent the abnormal death rate is caused by lack of proper food, the lodging of two or three families in the one dwelling, inadequate clothing, etc., all causes traceable to low wages. Tuberculosis is also making stupendous ravages in our population. This disease is recognized as the disease of the poor.

A community must, to retain its leadership, possess in its different spheres of activity the most qualified and competent men available. These men must be offered proper inducements in the form of substantial returns for their efforts to serve their fellow-citizens.

Has the City of Montreal managed to deserve the title of the Premier City of the Dominion?

Take, for example, the building industry, in which you are interested. If we may judge by the expressions of opinion we hear, too many jerry builders are allowed to operate without check. Strangers who visit our city criticize the lack of art and beauty in our suburban residences. This is partially true only. What is essentially lacking is a determined demand on the part of the parties interested to complete the building by-laws now six years under way. The jerry builder and the want of suitable building by-laws are, I submit, the causes for the erection of such structures.

How can we develop financially a municipality that will meet all the requirements of modern cities, if there is no stability in the earning power of the masses?

During periods of prosperity the pay envelopes of wage earners are well filled, resulting in the community at large benefitting by a freer and larger circulation of money. Conditions of life improve, and one of the most prosperous branches of business then is real estate. Rents are on the increase, the building industry thrives, and values in real estate follow the same course. Our municipal valuation is rated on this market value.

If there is no character of permanency in the income of salaried people; if at the first indication of a depression wages drop 25 to 50 per cent., immediately the purchasing power of each individual interested is decreased and general business is depressed. Rent, one of the principal items in a workingman's budget, is specially affected. Accordingly, some will leave the city; others will seek relief from the situation by renting rooms. The result is a very large increase in the number of vacant houses, diminishing the renting value. And this, in turn, is responsible for a reduction in the market value.

We all know municipal taxation is based mostly on the sales of immoveables, including rental value. The dire consequence is the impairment of the civic revenue.

Believe me, gentlemen, I do not mean to say that the present financial situation of the city is due entirely to the cause mentioned above; there are others. I am too familiar with civic affairs to ascribe our present penury to reductions in the wages of our workers, and it is not within the scope of these remarks to touch upon them.

The main cause is the war. Other causes are responsible, and one of these, I submit, is low wages. Every city on this continent has suffered on account of the war. None has been hit more severely than Montreal. After the war what are the chances of our city recovering from the depression, with some of our industries disorganized, empty stores and dwellings by the thousand? It will be a serious handicap; it will take years, in our case, to reach pre-war conditions.

The last, but not the least, of the evils connected with laxity in trade unionism is the lamentable effect it has on the political life of communities. Non-union men are necessarily discontented; and, lacking the satisfaction and self-reliance secured through membership in the organizations of their trades, they are easily misled and become the prey of politicians—I mean men whose main object is to secure their votes. Lacking completely constructive ability, their main object is to be elected and to keep themselves in office. Their principal asset is the gift of the gab. Promises are cheap, and in their speeches they always advocate reduction, if not suppression, of taxes. As to expenditures, their liberality cannot be exceeded (with other people's money always). Appropriations to charitable and other institutions and requests for increases in pay are always encouraged. Of course, the question of securing revenue to meet this beneficence remains in the background; it is not popular.

Designing, powerful corporations can easily capture such communities, and they do. Utility companies do as they please; popular candidates are elected and re-elected, to the surprise of good citizens, who are not familiar with the workings of schemers, large and small, who gravitate around our municipal halls. Orators at so much a speech are employed during election times, while a certain press is a powerful weapon at their command. If a good man is elected, he is subjected to all sorts of persecutions; false charges are laid against him, or he is ignored completely. To his surprise, his election is often contested, although he, perhaps, did not spend a cent in his campaign. So-called independent candidates spring up, supposed to be supported by no one, and yet as soon as they are elected their votes and actions soon demonstrate the mysterious force behind them; they are the tools of certain big interests. Domestic principles become a dead letter; inalienable rights are wrested from the people, and no one seems to care to take an aggressive attitude to defend these long-fought-for prerogatives.

Mr. Chairman and gentlemen, these are my views on the status of localities where there is no real spirit of solidarity between different classes of citizens. I have endeavored to be truthful; I sincerely believe I have not exaggerated. I am, perhaps, too moderate. I admit this statement is incomplete and far from perfect. No one realizes that more than I do. I have accepted your kind invitation for the reason that your fortnightly luncheons are open forums, the object of which, I presume, is to get the views of men in different walks of life. I thought it was a good opportunity to express the views of a labor man on some of the causes of our present difficult situation. I am not presumptuous enough to believe that my opinions as expressed will be shared by everybody, but there is one thing I desire to convey, and that is my ardent desire to do as much good as possible for my fellow-citizens of Montreal.

The Work of the Canadian Engineers in France

At a meeting of the Toronto Branch, Canadian Society of Civil Engineers, held in Engineers' Club, Friday evening, March 9, 1917, Capt. Mathieson, of the Canadian Engineers, gave an exceptionally interesting address on "The Work of the Canadian Engineers in France." Capt. Mathieson left Canada with the first Canadian forces as a subaltern in the 2nd Field Company, and is now in Canada on sick furlough. He was at the front for over seventeen months, and won the Military Cross for his good work in a number of the engagements in which the Canadians took a prominent part.

Importance of Engineer's Work

Capt. Mathieson told in a very graphic way of the importance of the engineers' work in this war. In the first few months the Royal Engineers in the British Expeditionary Forces, carried on the prescribed work of the engineer in battle, i.e., the construction and demolition of bridges, etc., helping the infantry in preparation of field works, etc.; but it was not until the settling down to trench warfare that the real importance and value of the engineer became apparent; and when the first contingent of the C. E. F. landed in France, the Royal Engineers were beginning to receive adequate status in the British Army. This did not extend to the Canadian divisions at first, but because of the excellent work done by the Canadian Engineers from the start, they soon established for themselves a very enviable status in the C. E. F., so that at the present time not a stick of material can be secured by the Canadian Army in France without the O.K. of an engineer officer; and the sapper (private in Engineers) is a foreman of "working parties," each party consisting of from 50 to 150 men.

Capt. Mathieson described the make-up of the line of trenches stretching from Belgium to Switzerland, and pointed out that the system of trenches practically constituted a city, and, eliminating luxuries, all the engineering work handled by a works department of a city was duplicated in some way at the front, the work having to be done under very adverse circumstances; as well, of course, was the work necessitated by the activity of the enemy. For instance, the water supply for troops was one of the big engineering problems. The speaker told of one of his personal experiences in estimating the water supply in a certain section. He went round with an interpreter trying to determine the water consumption in dry season; and one French woman said that there would be plenty of water for the troops if those Englishmen didn't wash so much.

Engineering Organization

The organization of the Canadian Army Corps was outlined, and also the Canadian Engineers' organization. The following outline of the engineer organization gives a good idea of how engineering work is taken care of:

The chief engineer, Canadian Corps, is a Brigadier-General. He has under him the four Colonels in command of the four units of Divisional Engineers, each consisting of 1 Div. Eng. H.Q's. and 3 Fld. Cos. He also has directly under him all corps troop companies and independent engineer officers attached to his staff who do the miscellaneous engineer work required behind the G.H.Q. lines.

Corps Troop Companies and the engineer officers attached to chief engineer's staff, look after the installation of water supplies for all units billetted behind G.H.Q. lines; look after the construction of G.H.Q. lines, construction of strong points between G.H.Q. lines and subsidiary lines; look after special railroad construction immediately behind G.H.Q. lines for the use of artillery; construction of all roads in the corps area up to the G.H.Q. lines, and all main roads from there forward to the most advanced point of motor transport; look after the construction of artillery route roads (both highway and railway) for supplying the heavy artillery with ammunition.

Apportionment of Work

The C.R.E. (or Colonel of Divisional Engineers) has at his command Divisional Engineer Headquarters, three Field Companies, the ordering of the work of one pioneer battalion and one tunnel company. He usually attaches one Field Company to each Infantry Brigade to aid them in carrying out the work in their area. The work in their area consists of the maintenance of the front line; communications to the support line; the support line; communications to the subsidiary line; and all strong points between the subsidiary line and the support line. In some instances they are given the maintenance of the subsidiary line to look after. The working parties for this work are supplied by the brigade in the line and are directed by the Field Company attached to the Brigade, but, in addition, this Field Company looks after the construction of all new lines in front of the subsidiary line which may or may not be built by working parties supplied by the Brigade; the construction of the subsidiary line, which is usually constructed by troops supplied by Division; the construction of strong points immediately behind the subsidiary line by working parties supplied by the Division; the digging of wells in the billeting area of the Brigade; the construction of roads in the Brigade area which are not main roads looked after by corps, and the construction of huts for billeting reserve battalions of Brigade; construction of routes for the use of working parties in dry weather; and all the innumerable drainage schemes required in the rear Brigade area, also the construction of light railroads in the Brigade area. At the same time, considerable portion of the personnel of this company may be working under C.R.E. for construction of such things as Divisional bath-houses, Y.M.C.A. recreation huts, etc.

The C.R.E. usually splits up his Pioneer Battalion by keeping one company to work directly under his own orders and attaching each of the other three companies to a Brigade to work under the orders of the respective Field Companies. The Tunnelling Company works directly under the orders of the C.R.E., and is supplied with material and working parties by the Field Company in whose Brigade area the tunneling company may be operating. The C.R.E. for the construction and maintenance of the works looked after by him also gets working parties from Corps Troops, such as battalions in Corps Reserve, Dismounted Cavalry, and any other units who may be at the disposal of Corps and lent to Division.

Responsibility of the Sapper

The lecturer emphasized the point that engineering work at the front was carried on by "working parties" drawn from the infantry and pioneer battalions, a "Sapper" from the Engineers being in charge of each working party. The Sapper must therefore be the foreman type—a man who can handle men and lay out work. The Engineer N.C.O. has charge of his Sappers, and therefore of a number of working parties; and the Engineer Subaltern in a field company has charge of the engineering work in the front, held alternately by two Infantry Battalions.

Capt. Mathieson described the interesting features of trench construction, construction of strong points, splinter proofs, dugouts, etc.; and told of the large amount of standard engineering material needed in this work, which standard material was made up in the engineer parks in the rear. These standard materials include splinter-proof frames, dug-out frames, "A" frames for trench revetting, bath mats, wire entanglements, etc. This engineering material is made up by working parties of tradesmen under supervision of sappers; and is brought up to the trenches by horse transport and by carrying parties. He outlined some of the difficulties met with by the engineers in siting trenches in ground which has been contested again and again, resulting in the mud being many feet deep, and interlaced with miles of wire entanglement, steel beams, corrugated iron, rifles, shell splinters, bodies, trench revettment, etc. To get a line of trenches fightable in ground such as this, doing the work at night in the dark is no child's play.

Capt. Mathieson concluded his talk with a strong appeal to every one present to get at least one man of the type required as a sapper in the Engineers interested, so that he would see Lieut. Armer at the Armouries, Toronto, and enlist in the Canadian Engineers.

The Canadian Fairbanks-Morse Company have secured a contract from the Corporation of Waterloo, Ont., for centrifugal pump, 960 imperial gallons capacity, against 220 ft. head, direct connected to 100 h.p. induction motor.

The Engineer of the Future

IN the Contract Record of Feb. 7, 1917, an extract of the essay that won first prize in the competition of the Chicago Association of Commerce was presented. The second and third prize articles, both entitled "The Engineer of the Future," are given below in extracted form.

Mr. Leo Shippy, author of the second prize essay, discussing this question, says:

Engineering in the Industrial Field

"Engineering, taken in its broadest aspect, is primarily industrial or business engineering. The different phases of engineering—civil, mechanical, electrical, etc.—are simply branches of this main trunk. The industrial or business engineer, the man with the brain of the engineer and the training in the science of business—for the business of to-day is a science—picks his lieutenants, his mechanical and electrical engineers, superintendents, and foremen from the ranks of those who have graduated from the engineering colleges.

"At the present time there are two classes of men from whom these industrial engineers are recruited: First, the business men who pick up a smattering of engineering and depend on their subordinates for the rest; and, second, the engineering graduates of our various colleges, who gain their business experience from the school of hard knocks. Now the logical men for these positions are the engineers, for it is easier for the engineer to incorporate the business science into his training than it is for the business man to pick up a technical training. But, as I have before stated, the engineers have had to secure their business training in the school of experience, and this has proved costly and full of mistakes.

Business Training for the Engineer

"The question, then, arises, if this be true, if this business science is so essentially a part of the engineer's training, why is he not given at least some of the fundamentals of it before he leaves college? Are the engineering colleges aware of this changed condition of things, and, if so, are they making any preparation to meet it by fitting their graduates to make the highest successes in their professions? The answer is that the engineering colleges are beginning to realize that the ideal of engineering has changed."

The author then presents the results of investigations to determine the advisability of the establishment of business and economic courses in engineering schools. In nearly all instances the general trend of opinion was that at least the fundamentals of such training in some form or other should be given at college, and that the undergraduates should be impressed with the importance of these studies, because, as a general rule, he does not realize the bearing that they have on his future success.

"Data from a great many engineering colleges reveal the same general truths as are made evident by the above, namely, that the engineering schools, almost without exception, are realizing the importance of incorporating the fundamentals of business and economic science into their engineering courses.

"As a result of investigation it has been found that the successful engineering alumni are almost unanimously of the opinion that their way would have been easier and their success greater had they had more training in business fundamentals while in college.

Engineering colleges, while they are not prepared at the present time to give this training, realize that there is such a need and are making preparations to meet it. So it is a foregone conclusion that the engineer of the future will be the man who has mastered the business science as well as the technical science of his profession."

The third prize essay on the same subject, by H. M. Kistler, says:

Development of Corporate Life

"Only a brief look into the past and a comparison with the present is necessary to reveal the modern tendency of business operations. Corporate life now seemingly as permanent as human life, has a desire to develop itself more fully, to extend its territories, to expand its powers, and this desire is being greeted with such success that it can only continue, on and on. It is contended that at some time the spirit of co-operation might be received more favorably, and might tend to replace capital in corporate control to a certain extent. However this may be, the result would be the same—big business.

"Now, what would seem to be the characteristics and requirements of a big business? These will be enumerated generally and briefly. It must have a board of keen executives; it must have a well-developed, highly-specialized staff organization, a well-trained, efficient line organization, the two of them moulded to work in perfect harmony. For its operation and life it would require structures and machines which, up to this time, have not been approached in size or efficiency of operation and design. The very nature of a big business calls for these things as prerequisites.

Administrative Work for Engineers

"It might be asked now: Will the engineer be found in or connected with these operations? Most assuredly he will, and to a much greater degree than ever before. Trained in daily contact with exact and inexorable laws, he is fast becoming more and more a leader in large affairs; he is fast taking his place at the head, and close to the head, of the great industrial concerns, and this he shall in no wise cease from doing. 'He will not replace men of other professions, for men bred to the law and men trained in business will always rise to the top,' but here is the contention—'the education and experience of an engineer especially fit him for high administrative positions not now commonly thought of as engineering work.'

"Now, will the big business maintain such a staff organization that the day of the consulting specialist will have passed? No; efficiency would forbid. The staff man will be a specialist, true, but the various phases of each branch of engineering are now being developed to such a degree that the staff man cannot keep apace with them all. He must call to the specialist who is engaged only in that practice under consideration, or in that practice along with one or more allied practices.

The Engineer in Business

"From the picture drawn the positions that may be occupied by the engineer will now be selected. In the line organization of the big business the young engineer may be found as a lieutenant in any of the various departments — operation, construction, design, sales, etc.; and, continuing up the line, the older man may be found in most any place, with the departmental manager's or president's chair as his goal. This tendency is developing to-day, and with the increase in big business it can only become more pronounced. The very nature of the staff organization, on the oother hand, requires that a part of it shall be composed of engineers, each one specialized in his particular line. Then, too, working with the staff and line, on unusual problems there will be the consulting specialist.

"In a crowd there will always be found tall men and short men, and so along with the big business there will always be the smaller concerns. These, too, will require their engineers, not so highly specialized, but differing from their big business brothers only in that respect.

"Again, the engineer of the future has duties to perform, aside from his professional ones. He is naturally a leader of men, and, as such, must assume his place in the community life, in the leading problems and questions of the time, even in politics. And, because of his position as an employer of men of all classes, upon him rests the responsibility for the welfare of these men. It is he who must carry on this big work; it is upon him that the obligation is laid."

Fireproof Factory in Hamilton Nearing Completion

THE construction company building the Mercury Mills, Limited, Hamilton, Ontario, is fast bringing it to completion, and it is expected to be in full operation within a short while. The buildings are of reinforced concrete construction, the flat slab or mushroom type of floor being used. This new plant is fireproof throughout.

The main mill is a three-storey structure with basement, and contains a floor area of about 70,500 square feet; the three-storey dyehouse, 27,400 square feet; and the two-storey picker house, 9,200 square feet. The plant, main mill, dyehouse and picker house will contain a total floor area of more than 100,000 square feet.

Progress view of Mercury Mills Factory

Two 150 h.p. tubular boilers are installed for heating the entire mill. Electric energy will be purchased for operating the machinery and for lighting.

While the reinforced concrete construction insures the permanence of the buildings themselves it does not protect their contents. This will be cared for by a complete automatic sprinkler system.

The new buildings are located on Cumberland Avenue, the main mills and dyehouse fronting the street. A spur track from the T. H. & B. Railroad runs into the mill yard.

Charles T. Main, of Boston, Mass., is the designing engineer and architect. The plant was so constructed that future extensions, both in height of buildings and in new buildings, can be readily cared for.

Mussens Limited, Montreal, have removed from 318 St. James Street, and are now occupying their new offices on the second floor of the McGill Building, 211 McGill Street, Montreal.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Leaks in Concrete Stopped with Hot Mixture of Cement and Caustic Soda

Leaks in concrete can be stopped in the face of running water, even when this is under some pressure, by enlarging the break and properly applying a hot mixture of cement and caustic soda, which sets almost instantly. This method is described by H. W. Strenli in Engineering Record.

Leaks of this kind frequently occur even in the most careful work. Sometimes they result from small defects in the joints between one day's concreting and the next, where a small area has not been perfectly cleaned, or where a low spot in the old concrete retains water used to wash the surface and forms a "honeycomb." Leaks are sometimes produced through no fault of the contractor where the concrete has been placed under extreme temperature conditions without sufficient provision in the way of expansion joints. Slight unequal settlement or shrinkage may also produce leaks.

When leaks develop it is generally too late in any case to remedy the cause, and the only thing left to do is to stop them, sometimes at the expense of considerable money to the contractor and worry to the engineer.

This is often done by piping the flow to one point, grouting in the pipe while it is passing the water, cutting the pipe off within the surface of the concrete and capping it, after which the hole left over the pipe is plastered up. This is a slow, expensive and puttering way of doing the job. Frequently the pipe rusts, discoloring the concrete and sometimes reopening the leak. There is always danger of this if the pipe is exposed to electrolytic action. Leaks may also be calked before plastering with jute, or with lead wool and wood wedges. Jute will only do for small leaks without much pressure, and many engineers do not approve of the use of wood left permanently in the concrete.

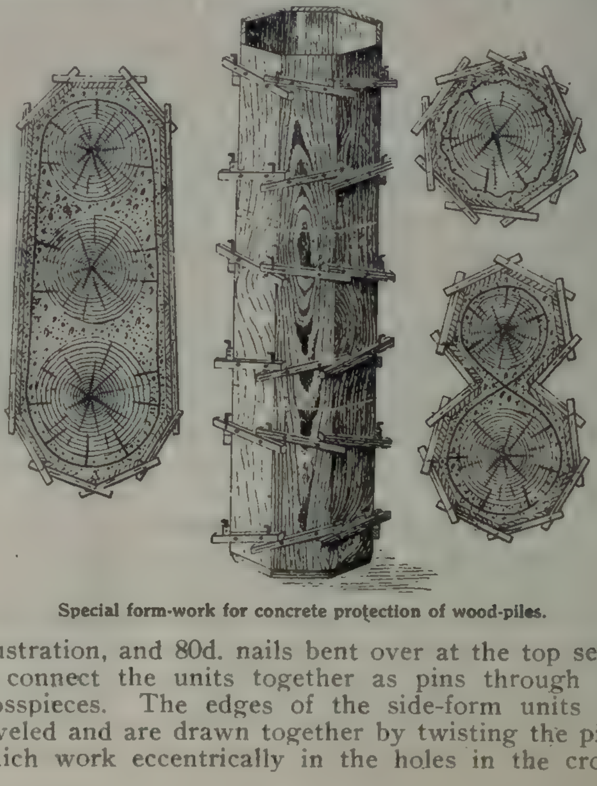
To overcome these objections the method referred to was developed by the writer in connection with other construction superintendents and engineers on sections of the Catskill Aqueduct and Passaic Valley sewer, where leaks which occurred months after the completion of portions of the work caused considerable trouble. The section of concrete around the leak is cut out to a depth of 3 or 4 inches with a chisel, so that the hole is larger at the base than at the surface. A small quantity of fresh Portland cement is then mixed with a boiling-hot solution of caustic soda into a thick paste, which is applied rapidly with the hands (which should be covered with rubber gloves) to one side of the cavity. The plaster is pressed firmly against the old concrete and held for a minute or more. In this length of time it sets very hard, and can only be removed with a chisel. This operation is repeated, following around the sides of the cavity, until a small opening remains, through which the water is now flowing. This small opning is again shaped with a chisel till the bottom is larger than the opening at the surface. Enough freshly-mixed paste is then taken in the hand completely to fill this opening, and applied suddenly with one hand, holding the paste in place for a few minutes. If the work has been done well, the leak will be completely closed.

Of course, practice is required for the successful use of this method, and there are several important points to be carefully observed. The soda must be of the best quality and fresh, very concentrated, and mixed with very little water. The mixture must be boiling hot when the cement is added, and the latter must also be perfectly fresh. Very little of the paste should be prepared at one time, as it hardens almost instantly. Just enough of the soda solution should be used to make a stiff paste, which should be mixed very rapidly by kneading it with the hands. The rubber gloves are essential, and anyone attempting to handle the paste without them will certainly regret it.

Wood-Pile Protection

A system of wood-pile protection from marine borers by the use of a concrete casing is described in Engineering News. The method of protection depends on the use of unit concrete forms for encasing piles above and below water.

These forms are made in units of stock-size lumber. Standard machine bolts are used for attaching the crosspieces to the side members, as shown in the illustration, and 80d. nails bent over at the top serve to connect the units together as pins through the crosspieces. The edges of the side-form units are beveled and are drawn together by twisting the pins, which work eccentrically in the holes in the cross-



Special form-work for concrete protection of wood-piles.

piece. These crosspieces or hoops are placed every vertical foot. The completed forms are hexagonal or octagonal in cross-section, and can be erected at any angle in order to enclose batter piles.

The equipment for a single concreting gang consists of 120 lineal feet of forms, which is enough to allow the concrete to set for 24 hours. Three flatboats, capable of carrying 1½ cubic yards each of concrete aggregate, a scow for water, with a deck for use as a concrete-mixing platform, two rafts for carrying the forms, and one small flat-bottomed rowboat complete the equipment. The working force consists of a foreman, two men to place concrete and erect the forms, and four men to mix and pour the concrete. This outfit, it is claimed, will place on an average of 40 lineal feet of concrete-pile casing per day. The work can be organized into any number of gangs of this size.

Wire mesh reinforcement may be used, the netting being held in place by nails and spikes driven into the piles.

Structural Material Consumption and Production in Canada

THE Dominion Department of Mines has just published a report by John McLeish, B.A., chief of the Division of Mineral Resources and Statistics, covering the production of cement, lime, clay products, stone, and other structural materials in Canada during the calendar year 1915, which is to be incorporated in the annual report on the mineral production of Canada for that year. The statistics included cover the production, imports, exports, and consumption of the above building materials. The total value of the production of these structural products in 1915, according to the report, was $17,920,759, as compared with $26,009,227 in 1914, a decrease of 31.1 per cent. Taking into account the exports and imports, the total consumption amounted to $21,314,029. Of cement alone 5,153,763 barrels were produced in 1915, a decrease of nearly 41 per cent. over the previous year. This production was derived from twenty plants, the year's production being less than one-third of the available capacity. The average price per barrel at the mill for all plants during that year was $1.23, the lowest value for a number of years. The cement produced in Canada includes an output of Puzzolan cement, made at Sydney, N.S., from blast furnace slag, and a small production of "natural Portland," made near Winnipeg. Of the total cement made in 1915, 429,268 barrels were made from marl and 4,724,495 barrels from limestone. Canadian-made cement represented 99.5 per cent. of the total consumption and the imported cement 0.5 per cent.

Clay Products

Clay products made in Canada comprise brick of various kinds, including common and pressed, ornamental and fancy building brick, paving brick, firebrick, porous fireproofing bricks and blocks, sewer pipe and drain tile, pottery and sanitary ware—the last two products chiefly from imported clays. The total value of clay products sold or marketed in 1915 was the lowest in ten years, and, compared with 1914, showed a decrease of 43 per cent. It was but a little over one-third of the maximum production reached in 1912. Sales considerably exceeded actual output, stocks having been depleted to a considerable extent to supply demand. Building and paving brick, including fireproofing brick, contributed 65.6 per cent. of the sales. Sewer pipe and tile production formed 29.5 p.c. of total. The average price of common building brick for the whole of Canada in 1915 was $7.48 per thousand, the lowest for a number of years. Ontario was by far the largest producer of clay products, having contributed nearly 58 per cent. of the total marketed during 1915. The falling off in sales was most pronounced in the Western provinces, a 64 per cent. reduction being noted, against a 36.7 per cent. reduction for the Eastern provinces. The imports of clay and clay products were equivalent to about 76 per cent. of the domestic production. About 45 per cent. of the 1915 production of sewer pipe and drain tile was made in Ontario. The pottery made from Canadian clays has hitherto been of very common grade, but some high-grade potteries were made from imported clays chiefly.

Decreased Lime Production

The production of lime in 1915, amounting to 5,047,244 bushels, was the lowest since 1908. The average price per bushel varied from a minimum of 17.3 cents to a maximum of 32¾ cents in British Columbia. Nearly 88 per cent. of the total production was derived from Ontario, Quebec, and the Maritime Provinces. Six firms reported the production of hydrated lime, and the Ontario Reformatory, at Guelph, produced a little "Alca" lime.

The production of sand and gravel in Canada during 1915 showed a falling off of 35 per cent., as compared with the previous year. The total value of the production of stone, including all classes of stone used for building, monumental and ornamental purposes, stone for paving purposes, curb-stones and flag-stones, rubble, rip-rap and crushed stone, limestone for furnace flux, sugar factories, etc., but excluding stone used for burning lime or manufacturing cement, amounted to $4,244,997, a falling off of 22 per cent. compared with 1914. The number of active firms was 236, employing 5,144 men. Lime stone formed 54.5 per cent. of the total production, granite 35.9 per cent., sandstone 5.9 per cent., and marble 3.7 per cent. Quebec shows the largest output, nearly one-half of the total production.

Letter to the Editor

Montreal, March 7, 1917.

Editor Contract Record:

Owing to absence from the city I have just read in the "Contract Record" for February 7th, a letter from Mr. D. T. Pierce, of the Barber Asphalt Paving Company, bearing upon my statement that "it should be quite safe to cut down the top thickness to three-quarters of an inch." It is interesting to know that in some cases, asphalt has worn down. These, however, appear to be exceptions. Would it be good practice to go to the expense of putting in thirty to fifty per cent. more than is necessary in most cases because it might be advisable in a few?

The paper was read for discussion and I am obliged to Mr. Pierce for bringing up the point. In the complete manuscript from which your abstract was prepared, no acknowledgement was made of the courtesy of the Barber Company in supplying me with slides showing the Trinidad and Bermudez fields. I take the opportunity of doing so now.

Yours very truly,

T. Linsey Crossley.

National Organization for War[*]

By Stephen Leacock.

The truth is that in all these things individual greed and selfishness obscure the issue. War brings with it the peculiar phenomenon of war prosperity. This, economically, is one of the most distressing things conceivable. Here is the interpretation of it: It is as if an industrious farmer and his family had worked hard for a generation and amassed flocks and herds, barns and buildings, and good stores of provisions and grain; then, in a moment of insanity, had set to work to burn the buildings, and in the warm light of the flames, kill and devour the animals, and gorge themselves with the grain and fodder, throwing the rest away. In this mad orgy one son of the family, more idiotic even than the rest, rubs his silly hands before the burning home, and leers: "Father, it is warmer here and nicer, and there is more to eat than in the old days, when we worked hard and had but little food. Father, we are prosperous. We have done a good thing." Then presently the fire burns down into ashes and the night comes and the dark. And where the grain once stood and the meadows smiled in the sun the wolves shall howl again in the gloom of the forest. And where the homestead was there will be graves. Such is the interpretation of war.

The farmer and the family are the nation, and the idiotic son laughing beside the fire is the war theorist talking of the boom of trade.

Patriotic Hypocrisy

But people either do not, or will not, know this. They still want their industry and its inflated gains, and was prosperity with the flush on its hectic face, and war pleasure with its strident laugh, dancing away the midnight hours. In and through it all moves smug hypocrisy, suggesting the little words and phrases that are to salve the soul; teaching the manufacturer to call himself a patriot as he pockets his private gains, and to shout for trade, more trade, that he may cram his pockets the fuller; teaching the farmer that his own fat, easy industry is war itself, and that he may count his fatted cattle in the light of his stable lantern and go to bed a patriot; teaching all the drones and parasites, the lawyers, the professors, the chefs and the piano players, the actors and the buffoons, that in going on with their business they are aiding in the conduct of the war.

"Business as usual!" shouted some especial idiot at the outset of the war.

The cry was like to ruin us.

What, then, are we to do By what means can we change from an economy of peace and industrial selfishness to an economy of effort and national sacrifice?

There are two ways in which this can be done; one that is heroic and impossible, another that lies easy to our hand.

The first is the method that nations adopt only in their despair, only in the last agonies of foreign conquest, as when Richmond fell, or when the Boers fought on in grim desperation across the naked veldt. Here national production ends, save only for necessary food and war supplies. Private industry is gone. Luxury is dead. All of the nations men are gathered into a single band. They do as they are told. They fight, they work, they die. Its women are in the fields, or they are making bandages; they tend the sick; they pray beside the dying.

Thus can a nation stand, grim and terrible, its back against the wall, till it goes down, all in one heap, glorious. In the wild onslaughts of the great conquests of the past, nations have died like this.

But for us, here and now, and in the short time that we have, this is not possible. Outside invasion could force us to it, in a jumbled wreck, with no choice of our own. But to accomplish this at a word of command inside our present complex industrial system is not possible. It is too intricate, too complicated, to be done by command from above. To enlist every man and woman in an industrial army, to direct their work and assign their rations—in other words, to create an ideal national war machine—is a task beyond the power of a government. Years of preparation would be needed.

National Organization

What we do must be done from below, using, as best we can, the only driving force that we know—the will of the individual. We must find a means that will begin to twist and distort our national industry out of its present shape till it begins to take on the form of national organization for war.

To do this we must exchange war prosperity for war adversity, self-imposed and in deadly earnest.

The key to the situation, as far as we can unlock it, lies in individual thrift and individual sacrifice. Let there be no more luxuries, no wasted work, no drones to keep, out of the national production.

Every man to-day who consumes any article or employs any service not absolutely necessary aims a blow at his country.

Save every cent. Live plainly. Do without everything. Rise early, work hard, and content yourself with a bare living. The man who does this—if he uses the saved money properly—is doing war work for his country. He may wrap his last year's coat about him and eat his bread and cheese, and feel that he, too, is doing something to show the world the kind of stuff that is yet left in it.

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[*] Extracts from pamphlet distributed by the National Service Board of Canada.

But he must use his savings properly. That is the whole essence of the matter.

Limit Buying to Necessities

Let us see what this implies. If the idea of national thrift were really to spread among us, there would be no more purchases of mere luxuries or things that could be done without—no more motors, no theatres (save where the work is voluntary and the money for the war), no new clothes (they would become a badge of shame), no books, no pictures, no new furniture, no new carpets, no victrolas, and for our children no new toys save such as can be made by the affectionate industry of a father working overtime with bits of stick and cardboard.

Such a programme would threaten to wipe out manufacturers and knock down dividends like ninepins. At first sight, a manufacturer, reading such an article as this, turns pale with indignation and contempt. Let him wait. Let us follow the money that is saved a little further and see what happens to it.

Every cent of the money that can be gathered up by national thrift should be absorbed by national taxes and national loans. Our present taxes are, for war time, ridiculously low as far as all people of comfortable, or even of decent, means are concerned. And they are made with one eye on the supposed benefit to industry. We need a blast of taxation—real taxation, income tax and all—that should strike us like a wave of German gas. As things are, we should go down before it. Armed with the new gas helmet of natonal thrift, we could breathe it easily enough and laugh behind our goggles.

Government Bonds

Over above the taxes we need a succession of government patriotic loans, not money-lenders' loans at market and super-market rates, but patriotic loans in the real sense, at a low rate of interest, let us say, 4 per cent., and issued in bonds of $25, with a dollar a year as interest.

The people, one says, will not subscribe. Then, if not, let us perish; we do not deserve to win the war.

But they will subscribe.

If, under the auspices of our government, a national campaign for thrift and investment is set on foot; if we give to the ideas all the publicity that our business brains can devise; if we advertise it as commerce advertises its healing oils and fit-right boots and its Aphrodite corsets, then people will subscribe, tumultuously, roaringly, overwhelmingly.

If not—if that is the kind of nation that we are—let us call our soldiers home from the western front. They are fighting under a misunderstanding. The homes that they are saving are not worth the sacrifice.

But first let the government—of the dominions, the provinces, the cities, and the towns—itself begin the campaign of thrift. At present vast sums of money are being wasted in so-called public works—railways in the wilderness, cement sidewalks in the streets, post-offices in the towns—millions and millions that drain away our economic strength. In time of peace these are excellent. For war, unless they have a war purpose, the things are worse than useless. The work of the men who labor at them is of no value, and the food and clothes that they consume must be made by other men.

Let us be done with new streets and new sidewalks, new town halls, and new railways till the war is done. Let us walk in our old boots on the old boards, patriots all, with dollar pieces jingling in our pockets adding up to twenty-five for the latest patriotic loan.

Let us do this, and there will pour into the hands of the government such a cascade of money that the sound of it shall be heard all the way to Potsdam.

What Can You Make?

And here enters the last step to be taken under natoinal thrift to convert ourselves into a war economy. The government goes with its money to the manufacturers and interrogates them. What can you make, and you, and you? You have a plant that has made buggies and fancy carriages. These our people will not buy because now they walk. But what is it that you make? Can you turn yourself to making trucks, wagons? You, that made boots and have lost half your trade, what about a hundred thousand boots for the army? You, that made clothes, what about doing the whole thing over in khaki?

The needs of a war government are boundless, endless. The list of its wants is as wide as the whole range of our manufactures. The adjustment is difficult. Not a doubt of it. It cannot be done in a day. But with each successive month the process would go on and on till we would find ourselves, while working apparently each for himself, altered into a nation of war-workers, every man, in his humble sense, at the front and taking his part.

Meantime, we at home are doing nothing, or next to it, for the war. While we go about our business as usual, men are breathing out their lives for us, somewhere in France.

What shall we do?

Electro-Chemical and Metallurgical Possibilities in Canada

By H. E. Howe*

In considering the utility of hydro-electric power, we must remember that it is simply another way of selling energy, and its cost must always be compared with the cost of energy in other forms, such as coal. It may be expected, therefore, that hydro-electric development will be more extensive in the immediate future in Canada than in the United States, for example, where coal is found relatively near the industrial centres and at points where it can be used direct, or where gas from by-product coke ovens can be used to produce electric energy at a price competing with its cost when generated by hydro-electric power. It must be borne in mind that while steam plants are now producing power with approximately one-half the coal required fifteen years ago, and at a capital cost of little less than half what it was at that time, hydro-electric equipment had a very high initial efficiency, and consequently has not enjoyed anything like the same degree of improvement, while the cost has in no way decreased. In fact, owing to increased prices of materials and labor, the cost per horse power is probably higher than it was fifteen years ago.

Therefore, the fact that a water power exists and offers opportunity for development as a source of electric energy does not necessarily imply that it is economical to develop it or that developed, a group of industries will at once find a home in that vicinity.

Must Be Demand for Products

Let us consider for a moment whether electro-metallurgical and electro-chemical industries are in order for Canada at the present time. Two things enter into this consideration—first, is there sufficient demand for the products of these industries; and, second, are there not other demands for electric power which at present must supersede such industries? Almost without exception electric products are the raw materials for other industries; we must have a relatively large number of such industries before the establishment of electro industries can be justified. As to the second point, it would seem that a market for labor is one of the commanding questions before Canada at the present time, especially in view of the return of soldiers and the expected immigration of many hands, who will want employment in other than agricultural pursuits.

Other industries, such as spinning and weaving, employ many more hands per horse power of electric energy consumed than do electro-chemical and metallurgical plants, and can afford to pay a higher price. Such employment, in turn, builds up communities and offers opportunities for wholesale and retail merchants and the host of secondary industries incident to any concentrated population. If we consider the relation between the horse power consumed in Niagara Falls, N.Y., or Ontario, in relation to the population of these places and apply the same line of reasoning to the locality of Manchester, N.H., or Lowell, Mass., this point will at once be emphasized. It must be obvious that electro-chemical and electro-metallurgical industries face another handicap, for with the building up of the consuming population and industries utilizing electro products there comes a growing and insistent demand for power, which tends to place the cost of electric energy at a higher price than such processes can afford to pay. They are, therefore, gradually forced to seek advantageous points at a little distance from the large centres, but these points can only be chosen where the reasonably low incoming and outgoing freight rates are available.

Let us consider some of the points determining the location of electro industries.

Factors Determining Location

First, there must be a source of large blocks of power. The fixation of atmospheric nitrogen, for example, requires 25,000 kilowatt hours to produce one ton of 100 per cent. nitric acid. The manufacture of aluminum requires a like amount of power per ton of finished product. The production of ferro-alloys which have become an essential in modern industry for the making of high speed steels, the hardening of armor and piercing projectiles, consume from 3,000 to 8,000 kilowatt hour per ton of product, depending upon the grade of alloy made. The process of casting an alloy or refining steel consumes from 600 to 1,000 kilowatt hours per ton, while the refining of nickel requires energy to the extent of 3,000 kilowatt hours per ton. Lead is the smallest power consumer, since only 120 kilowatt hours per ton of refined product are required, while copper at 300 kilowatt hours per ton is next. It is evident, therefore, that different industries require blocks of power from 5,000 to 50,000 kilowatt hours.

Second, this power must be reliable. It should not be subject to great variation, for in electric furnace operations, especially, it is frequently fatal to have a sudden diminution in the amount of power available. This means that in some instances a water power which is subject to severe ice conditions or where the flow of water materially decreases in summer must have a steam plant as an auxiliary if a high average of efficiency is to be derived from the water power itself during other seasons of the year.

Cheap Power Necessary

Third, the power must be cheap, far cheaper than many suppose, if electro-chemical and metallurgical processes are to be established on anything approaching a large scale. Twenty dollars per horse power year, which is equivalent to 3c per kilowatt hour, is not cheap. Many important processes cannot live at that price. By locating a plant equipped with modern turbo-alternators near the coal fields it is possible to meet this figure through the generation of electricity from steam power. Artificial fertilizers and the great group of industries depending upon nitrates must have power considerably below $10 per horse power year. Dr. Eyde stated in 1912 that when electric energy in Norway exceeded a price of $6 per horse power it would become impossible for the great plants, so favorably located, to compete with other sources of nitrates.

Fourth, there must be reasonably cheap freight rates from the plant to the consuming industries and on the raw materials which must be brought in. Electro-chemical industries are large consumers of such materials as salt, coal, silica and calcium compounds, and in many instances their products must be sold at a price which precludes the possibility of paying large amounts for freight.

Transportation an Important Item

Fifth, for this reason the nearness to consumers is almost always an essential. It has been estimated that a distance of 1,000 miles to the centre of distribution is equivalent to an increase of from $10 to $20 per horse power year in the cost of power itself. Where raw materials are bulky and the product is not bulky, work must be carried on near the raw materials. Where large amounts of power are essential it may pay to bring the raw materials to it. Such questions must be separately considered in each individual instance.

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*Assistant to the president, Arthur D. Little Company, before Canadian Mining Institute, March 7.

Sixth, there must be good labor conditions; and, finally, raw materials must be available.

Relatively higher prices can be paid for electric power only where the most favorable conditions of locality, market, freight rates, accessibility to raw materials and labor conditions exist. An exceptional advantage for any one of these five factors may be sufficient to overcome a considerable weakness in one or more of the others. For example, in Norway power is so cheap and a large market so near, with water transportation, that a very large carbide plant is being installed, even though some of the raw materials must eventually come from a considerable distance. Niagara Falls is a most unusual locality, and, because of its exceptional advantages, must not be taken as a criterion for possible developments in other places as they exist at present.

Satisfactory Conditions Essential

It would seem, therefore, that while Canada's hydro-electric power offers many potential opportunities, it must be considered at present a reserve, and several conditions must be satisfactory before definite recommendations can be made. First, we must know more about Canadian natural resources that lend themselves to the treatment of electric processes, and we must have information in more available form than at present; second, the selection and establishment of an industry utilizing electric energy must be done with great care and with a thorough study of the economics in each instance; third, there must be a larger consuming population in Canada before the introduction of many of the electric industries can be justified; fourth, there must be more industries using electric products as their raw materials; and, fifth, really cheap power must be available.

To bring about this latter condition there must be lower costs for development. Many of the great power companies have been obliged to spend considerable money and embellishment, owing to the location of their power plants, which has added much to the cost per horse power. Owing to several uncertainties, money used in development has had to pay a higher interest rate than in other forms of industrial activity, and, besides, it costs nearly three times as much to develop a water power as it does to construct a steam plant to produce the same amount of kilowatts per hour. If capitalists would accept bonds at 5 per cent. instead of 7 per cent. the cost of production of a horse power hour would be reduced 22 per cent. Railways and other forms of industries seem to have no difficulty in obtaining money at this rate, and it may eventually become necessary for governments to use their credit to obtain money at low rates to assist in water power development. There must also be reasonable and co-operative legislation to insure the permanency and safety of private investments in such projects.

Electro-metallurgical Field

Based on these principles, the immediate future seems to offer Canada two fields for the utilization of hydro-electric power in electro-metallurgy and electro-chemistry. Perhaps the most important is the electro-metallurgical field. Here Canada has the raw materials; she has the consuming market for much of the material to be used in the construction work which must go forward, while in many instances the products can be exported to advantage by all water routes. Hydro-electric power would seem particularly well adapted to this industry here, because electric furnaces do not require the peculiar crucible clays which would have to be imported; the product is of the highest grade, and the fuel which we should feel called upon to conserve for the sake of posterity is replaceable with electric energy in the form of heat. Every million kilowatts used is equal to eleven and a half million tons of coal per annum, and it must be remembered that under the most favorable conditions it requires four pounds of coal to develop one horse power. Electro-metallurgic processes have already a strong foothold in Canada, and important developments have been the result. I refer to the production of ferro-titanium directly from the ores and, concurrently with it, the manufacture of high-grade irons from the titaniferrous iron ores of Canada, which have constituted a problem. You are also aware of the important place which electro-metallurgy holds with relation to munition manufacture. The indications, therefore, seem to be that further development, not only in the smelting of ores but in the utilization of scrap materials, lies in the immediate future.

Developments in Electro-chemical Field

In the electro-chemical field there are also instances of important developments, such as the group of processes at Shawinigan and at Niagara Falls, Ont. The production of nitrates now illustrated by the American Cyanamid Company at Niagara Falls, Ont., would seem to offer the best electro-chemical field, but it must have far cheaper power than is now offered if considerable expansion is to be expected. The production of nitrogen fixation is of great economic and national importance. Nitric acid is the basis of many chemical industries, is an absolute essential in all explosive manufacture, and is required in ever-increasing amounts for the production of fertilizers. Canada must eventually use fertilizer. It is well known that we cannot continually draw money from the bank without occasionally depositing funds, and yet we hear stories of how rich the farm lands used to be, forgetting that the fertility of a virgin soil must gradually disappear unless replaced in some measure. Those nations praised for the yields per acre are also the nations where the greatest amounts of fertilizer are used annually per acre. The fixation of atmospheric nitrogen is a large consumer of power; the product will stand reasonable transportation charges; a nation cannot be wholly independent without nitrates, and for these reasons this particular electro-chemical process would seem to command early attention.

Although it is beyond the province of this discussion, the utilization of hydro-electric power to a greater extent in transportation may be mentioned. The heavy initial investment is a serious factor, but against this may be mentioned the conservation of fuel, the fact that many water powers exist where grades are heavy and population sparse, and the fact that considerably greater motive power can be obtained from an electric locomotive than it is possible to develop from the most modern steam locomotives.

In considering the possibility of saving coal through the utilization of hydro-electric power it is interesting to note that prior to the war France consumed about 60,000,000 tons of coal per year, of which 33 1/3 per cent. was imported. Now the Germans hold a good part of the French mines, and it is needless to say that when they are returned to France they will be well worked out. Consequently a survey of the water power resources of France has been made, with the result that power estimated at from 6,000,000 to 10,000,000 horse power has been located. About 45,000,000 tons of coal are used annually in France for power, producing 12,000,000 horse power. The development of 6,000,000 hydro-electric horse power will represent an annual saving of over 20,000,000 tons of coal.

The cheapness of electric power determines to a great degree the future of electro-chemistry and electro-metallurgy in Canada, as well as elsewhere. I have attempted to set forth some of the limitations governing present processes, but with cheaper power it is not at all unlikely that new processes will be devised and new products be produced that may entirely alter the situation as it appears at present. Cheap power will also largely determine what can be done with existing processes.

The C. S. C. E.'s New Secretary

Mr. Fraser S. Keith, B.Sc., A. M. Can. Soc. C. E., who has been appointed secretary of the Canadian Society of Civil Engineers, as noted in the Contract Record of March 7, was born in Smith's Falls, Ont., on June 8, 1878. He entered the Faculty of Applied Science of McGill University in 1899, graduating with honors in electrical engineering in 1903. Mr. Keith has devoted many years to editorial work, for after spending a year on the electrical engineering staff of McGill University, he became editor and, later, manager of "Canadian Machinery." In 1907 he became editor of "The Canadian Manufacturer." Mr. Keith then spent eight years in the West as a practical contractor and engineer, returning east in 1915 to resume editorial work as editor and manager of "Construction," which position he leaves to take up his new duties. Mr. Keith's wide acquaintance with Canadian industrial conditions and the development of our natural resources specially fits him for his new position as secretary of Canada's national engineering society.

Fraser S. Keith, B.Sc.

Mainly Constructional

East and West—From Coast to Coast

Notice has been given of an application to parliament for legislation to incorporate the "Dominion Good Roads Association."

The Toronto City Council has given a grant of $15,000 to the Grace Hospital to cover the cost of a number of structural and other improvements at the institution.

A new military hospital at Esquimalt, to serve the needs of the Pacific Coast and to take the place of the present inadequate institution, is being planned. It has not been decided whether to build at once or delay operations until after the war.

It is stated that the Ellison Milling and Elevator Company contemplate the erection of a large grain elevator at Lethbridge, Alta., providing the Dominion Government does not establish one there.

City Engineer W. P. Near, of St. Catharines, Ont., has been instructed by the council to make a survey and report on a sewer system for the section of the Western Hill south of the Grand Trunk Railway.

The Toronto City Council has refused to approve the plans of the Canadian Pacific Railway's double track railway from Yonge Street to Leaside, pending agreement as to a subway at Summerhill Avenue.

It is reported that the Riordon Pulp and Paper Company is planning to establish a large sulphite plant in connection with their present plant at Haileybury, Ont. Options are said to have been closed on the adjacent property and plans and surveys already completed.

The Council of the town of Welland, Ont., will ask permission of the Ontario Legislature to unite with a section of the Township of Crowland and incorporate the whole as the city of Welland. The principal reason for this action is the rapidly increasing tax levied by the county.

Hon. T. W. McGarry has introduced legislation in the Ontario house to amend the Tile Drainage Act. The object is to increase the amount which can be loaned to any one municipality from $50,000 to $100,000 and the total which may be loaned under the Act from $500,000 to $1,000,000.

The Hon. Albert Sevigny, Minister of Inland Revenue, recently stated that the improvements to the harbor at Quebec will be pushed with vigor in the spring. With regard to the work at the drydock at Lauzon, he said operations would be commenced as soon as the weather conditions permitted.

The City Council of St. Catharines, Ont., have concurred in the recommendation of the works committee, that a four-foot concrete sidewalk be laid on the northerly-side of Myrtle Street, from Geneva Street to Wiley Street, and on the southerly side of Permilla Street, from Dexter Street to McDonald Street.

A concrete road from Winnipeg to Transcona, via Nairn Road, Elmwood, is contemplated, and a great deal of interest is exhibited by Winnipeg business men, many of whom have promised handsome donations toward the cost if the government will pay a portion. The estimated cost of the work is $63,000.

Building permits for the month of February, 1917, for 38 cities of Canada amounted to $1,503,939, as compared with $662,135 in the corresponding month in 1916, an increase of approximately 125 per cent. The greatest gain was in Eastern Canada, the figures being $1,365,497, as against $553,406. The figures for the four Western provinces total $138,442, as against $108,729.

Commissioner R. C. Harris, of Toronto, has reported to the Board of Works that it would cost $190,000 to continue a civic car line on Coxwell Avenue, from Danforth Avenue to Gerrard Street. He stated that the expenditure would be useless if the proposed hydro-radial entrance is considered, as the same territory would be served by a parallel line. The report has been shelved by the board until the hydro-radial entrance question is properly dealt with.

The chancellor of Queen's University, Kingston, Ont., Dr. James Douglas, of New York, has agreed to give $100,000 towards a fund to develop Kingston General Hospital into a capacious, modern institution, and especially with a view to the improvement of its teaching facilities in connection with Queen's University School of Medicine, making research work possible. The hospital board will engage a hospital architect to draw plans and later will place the matter before the legislature and the municipal councils of Eastern Ontario.

The Board of Trade of Welland, Ont., recently passed a resolution recommending that the Department of Railways and Canals begin at once the necessary plans and surveys for the building of a canal and river system from the foot of Lake Ontario to Montreal of a character and capacity to conform with the plans for the Welland Ship Canal, so that the department may be able to proceed with the work as soon as possible after the termination of the war.

It is said that at least 500 more houses are needed in Welland to accommodate the increasing population, due to industrial development. Real estate men, however, say there is little prospect of an early improvement in conditions. This is due, no doubt, to the increased cost of building, which in many cases makes it an unprofitable investment. The situation in Welland is reported to be serious, many small houses accommodating two families and some more than two, while a great many people are unable to get any accommodation whatever.

Engineers of the Greater Winnipeg Water District are engaged in preparing plans for the tunnel which is to carry the Shoal Lake aqueduct under the Red River. The surveys show that the tunnel will have to be driven through solid rock at a depth of about 75 feet below the land surface. The rock is a limestone formation, the same as that which outcrops at St. Andrew's. The contract for the tunnelling will not be let until next fall. The tunnel will pass under the river at a point opposite Victoria Park at the foot of Rupert Street. A tunnel will also have to be built under the Seine River in St. Boniface.

At a meeting of the council of the Board of Trade at Sidney, B.C., recently the question of Sidney wharf improvements was discussed. It was decided to enlist the assistance of the manager of the V. and S. Railway in procuring a suggested new float and the removal of the old piles in the disused wharf. The meeting also discussed the question of the construction of a wharf by the Dominion Government at the north end of James Island, for the benefit of the people living there. A resolution was passed endorsing the application of the Canadian Explosives Company for the construction of such a wharf and is to be presented to the proper authorities.

Plans have been completed by J. C. M. Keith, architect, for the addition to the nurses' home in connection with the Royal Jubilee Hospital, Victoria, B.C., and tenders called. The addition will be a frame structure, three storeys in height, besides an attic, and will correspond in style to the present home. When completed it will give additional accommodation for 28 nurses. The first floor will consist of a lecture hall and bedrooms; the second will contain a sitting-room and bedrooms; and the third will be devoted entirely to sleeping apartments. The walls will be shingled and the roof covered with slate. All the plumbing arrangements will be of the most modern nature.

Contractors of Sarnia, Ont., are busily engaged in the erection of houses in the southern part of the town, and have secured contracts for building several others. The tendency seems to be for Sarnia to extend towards the south, and it is in this quarter principally that the contractors are operating. The residences being erected are designed chiefly for the use of workingmen, and a great many are built on the bungalow style, with living-room, dining-room, bedroom, kitchen, and bathroom on the main floor, and two small bedrooms in the upper storey. These houses, when completed, will be moderately priced, and will sell at from $1,500 to $2,000, a figure which is expected to appeal to the average workingman. They will help very considerably towards relieving the house shortage which now prevails in Sarnia.

At a recent meeting of the Board of Works of Burnaby, B.C., Mr. F. L. Macpherson, municipal engineer, submitted a report regarding the opening of a highway from the Burnaby Lake district direct to Kingsway, in reference to which a deputation recently waited upon the council. There are two proposals. One is to open up Burris Street and the other is by way of Gilpin Street. The Burris route covers 2.6 miles, and the engineer estimated that it would cost about $2,250 to put it into condition for light traffic and from $4,000 to $6,000 to render it suitable for automobile traffic. The Gilpin Street route would require an expenditure of about $5,475. The distance this way is 3.9 miles from the lake to Kingsway. The present route, via Douglas Road and Edmonds, is 4.6 miles. It was decided to send a copy of the report to the Burnaby Lake petitioners.

A request that the provincial government contribute 40 per cent. of the cost of maintaining the new Toronto-Hamilton highway was made to Hon. Finlay Macdiarmid, Minister of Public Works and Highways, by a gathering of representatives of all the municipalities interested in the highway. The request arose out of a discussion of proposals made by the Toronto-Hamilton Highway Commission at a conference at the parliament buildings, that instead of continuing to pay for repairing the sides of the highway, at a considerable cost, macadam shoulders be constructed on each side of the pavement. The chairman, George H. Gooderham, M.P.P., considered that since the betterment of the road now by adding the shoulders would save maintenance costs in the future, the costs should be met by the municipalities, as they would meet the maintenance charges. The question of constructing the shoulders was left in an indefinite form, the commission being authorized to go ahead with betterment work up to a limit of $300 a mile, conditional upon the government paying its share.

Hon. T. H. Johnson, Minister of Public Works, recently presented to the Manitoba Legislature a draft order-in-council with regard to the awarding of the contracts for the completion of the Manitoba parliament buildings, which he recommended to the government. In bringing in this draft order, Mr. Johnson mentioned that, by simplifying the plans and securing greater competition in tenders, a saving to the province of $1,289,587.89 had been effected, the general contract having been awarded to the J. McDiarmid Construction Company, at $1,785,681. The Minister recommended that in any contract entered into, a proviso should be embodied reserving the express right to close down the whole or any part of the works during seeding or harvest time in any year while the work is in progress, without any allowance or recompense of any kind whatsoever to the contractor for any loss or inconvenience, except that the length of time of such compulsory cessation shall be added to the time limit of the contract. Mr. Johnson said that the government was not prepared at the moment to announce whether the work will be let forthwith or left over till after the war. Opposing recommendations had been made by numerous bodies in this regard.

Personals

Mr. J. H. O'Hara, it is understood, will probably be re-engaged as engineer for Surrey municipality, B.C.

Mr. L. S. Derosia, formerly with the Case Machinery Company, Toronto, has joined the staff of the road and plowing machinery department of the Canadian Fairbanks-Morse Company, Montreal.

Trade Publication

The Portland Cement Association has issued a booklet entitled "Your Streets," which is distributed to persons interested on request.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Cayuga, Ont.
Plans have been prepared for a $7,500 waterworks extension for the Village Council. Engineers, Jackson & Lee, Temple Bldg., Brantford.

East Nissouri, Ont.
The Township Council are considering the construction of the "Muir" drain this year. Secretary-treasurer, J. W. Suthland, Lakeside.

Edmonds, B.C.
The city propose spending $35,000 for road and bridge work this year. Address, Reeve Fraser, City Commissioner.

Lindsay, Ont.
Reese Williams has been awarded the general contract and will carry out the stone, brick and carpentry work for a $35,000 addition to the pump house, etc., of the Water Commission, Town Council.

London, Ont.
Plans will be prepared for a $47,000 waterworks extension for the Utilities Board, City Council. It has been decided to use wooden conduits. General manager, E. V. Buchanan.

Mount Johnson, Que.
The Municipal Council are considering the construction of seven miles of sidewalks. Secretary-treasurer, Adonai Quintin.

Nepean Township, Ont.
The Township Council are preparing estimates for sidewalks.

New Toronto, Ont.
The Town Council have instructed James, Loudon & Hertzberg, Excelsior Life Bldg., Toronto, to prepare plans for an extension to the present waterworks system to cost $40,000. Clerk, Geo. D. Scott.

Oshawa, Ont.
The Town Council are considering advisability of using water from stream instead of pumping from the lake. Project likely to cost about $150,000. Engineer, W. G. Worden.

Simcoe, Ont.
Town Council are considering the purchase of 6,200 feet of 8-inch and 4,000 feet of 6-inch vitrified sewer pipe. Clerk, W. C. McCall.

Smith's Falls, Ont.
The construction of a sewer on Union Street to cost $6,000, is being considered by the Town Council. Engineer, S. B. Code.

The construction of a sewer and watermain on Smith's Falls Ave. to cost $4,000 is contemplated by the Town Council. Engineer, S. B. Code.

Victoria County, Ont.
Good Roads System by-law passed by County Council has been sent to the Highways Department, Toronto, for approval of mileage. If ratified by Government a committee will secure necessary machinery, etc., in order to make a start, but work will not go ahead extensively until after the war.

CONTRACTS AWARDED

Pointe Claire, Que.
The New York Continental Jewell Filtration Co., 10 Cathcart St., Montreal, have been awarded the contract for a chlorinator for the filtration plant.

St. Hyacinthe, Que.
The following contracts have been awarded in connection with the construction of a filter system for the Water Works Committee, City Council, by the Roberts Filter Mfg. Co., Darby, Penn.:—Construction, L. A. Ott, New Birks Bldg., Montreal; motors and generators, Canadian General Electric Co., 162 St. Antoine Street, Montreal; turbine pumps, De Laval Dairy Supply Co., Ltd., 43 Richmond St. E., Toronto; cast iron pipe, Canada Iron Foundries Ltd., Victoria Sq., Montreal. Heating, lighting and roofing contracts to be awarded.

Sombra Township, Ont.
The Town Council have awarded the general contract for repairs to the "Huey" tile drain to Roy Wade, care of Clerk, W. A. Scott, Bickford.

Tecumseh, Ont.
Wm. Newman, care of Engineer, Windsor, has been awarded the contract for well and intake, Ernest Hill, care of Engineer, Windsor, the pipe laying contract, and the Canadian Allis Chalmers, 212 King St. W., Toronto, the contract for supplying pipe, pumps, motor and installation for the waterworks system for the Eau Claire Waterworks Co., Ltd., costing $20,000. Engineer, R. W. Code, Board of Trade Bldg., Windsor.

Railroads, Bridges and Wharves

Bay Shore, N.S.
The Canadian Pacific Railway, Head Office, Montreal, Que., contemplate the addition of six stalls, also a 40,000 gallon water tank will be erected. Purchasing agent, E. N. Bender, Montreal.

Harding, Man.
Tenders will be received by the Secretary-treasurer of the Municipal Council or the Department of Public Works, Winnipeg, until April 21 for the erection of a steel and concrete bridge over the Oak River north of Griswold.

Manitoba, Province of
J. D. McArthur and associates will build railway from East Selkirk to Fort Alexander with Government aid.

New Toronto, Ont.
The Town own about 200 feet on Lake Shore and propose erecting a stone sea wall 6 feet above lake level. Clerk, Geo. D. Scott.

St. Thomas, Ont.
The City Council plan to extend street railway line to Queen and Centre Streets.

Smelter Junction, B.C.
The Canadian Pacific Railway, Head Office, Montreal, Que., are considering the erection of round house shops, side tracks, etc. Assistant Purchasing Agent, S. G. Denman, Vancouver.

Toronto, Ont.
Commissioner of Works R. C. Harris will include in his estimates for this year $200,000 for new bridge to replace present structure on Glen Road.

Upper Kent, N.B.
The Canadian Pacific Railway, Head Office, Montreal, Que., will build a 1-storey station house between Woodstock and Andover. Purchasing Agent, E. N. Bender, Montreal.

CONTRACTS AWARDED

Brantford Township, Ont.
Bain & Ross, Embro P. O., have been awarded the general contract and will start work about June 1 on the erection of a $5,300 bridge over Whiteman's Creek for the Township Council. General contractor will purchase 2,000 bags of cement and 18,000 pounds of reinforcing steel bars. Engineers, Jackson & Lee, Temple Bldg., Brantford.

Public Buildings Churches, and Schools

Aubarndale, Alta.
Tenders will be received by the secretary-treasurer of School District No. 3442, A. J. Newman, until noon March 31 for the erection of a frame school.

Brampton, Ont.
Wickson & Gregg, Kent Bldg., Toronto, have been appointed architects and tenders will be called about April 14 for the erection of a $60,000 high school for the High School Board. Chairman, Dr. J. G. Roberts.

Chicoutimi, Que.
H. La Montagne has been appointed architect and will prepare plans for a 4-storey addition to the monastry owned by the Hotel Dieu St. Valier. Work to start in the spring. Chairman of Building Commission, Sr. Ste. Madeleine.

Fredericton, N.B.
R. A. Corbett, 272 Douglas Ave., has been awarded the general contract for the erection of an $18,000, 2-storey school annex on Charlotte Street for the School Board. General contractor is in the market for 140,000 stock brick, 500 bags cement, 28 squares of Rubberoid roofing.

Grande Prairie, Alta.
Tenders are being received by the Secretary-treasurer, J. Fitzallen, until noon April 14th, for the erection of a brick veneer school for the School Board, Edmonton. Plans and specifications with the secretary-treasurer.

Halifax, N.S.
The Military Hospital Commission, Metropole Bldg., will call tenders shortly for the erection of three military hospitals.

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Contract Record and Engineering Review

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Alphabetical Index of Advertisers
Page 16

Vol. 31 March 28, 1917 No. 13

Principal Contents

	Page
Editorial	273
Constructional Details of Big Aqueduct	275
Grand Pabos Pulp Mills	277
Canadian & International Good Roads Congress	278
Cost Accounting for the Contractor	279
Grain Elevators in Western Canada	281
Timber Bridge Floor Fires	282
Practical Scheme of Vancouver Harbor Commission to Provide Cheap Industrial Sites	284
Sherbrooke's Development in Industrial Conditions	285
Practical Hints for the Contractor	287
The Water Powers of Western Canada	288
Mainly Constructional	292

Co-operative Municipal Bureaus

TO locate some of the grossest examples of inefficiency, one need only observe the methods of governing certain of our towns and cities. True, of course, the majority of civic servants and municipal officials are conscientiously devoting their energies to a proper operation of their respective departments, but the intricacies, perplexities and uncertainties of civic problems offer barriers on which scrupulous officials have oftentimes foundered. Guesswork replaces accuracy in the solution of these matters simply because there is a lack of knowledge about civic questions or insufficient time and inadequate facilities for gathering the data requisite to a satisfactory working-out of complicated municipal problems. One city's troubles are, in the end, but typical of those of any other city and the solution can be effected in much the same way, but there seems to exist no easy or effective means for one town to learn how sister communities have solved matters of a like character. Matters that ought to be investigated but once for all cities are being worked out by many civic bodies with an unnecessary duplication of time, labor and expense. There is no certain way of making the systems and results of civic measures common property.

* * *

Attempts have been made to bring order out of chaos and to establish municipal unions or research bureaus, or by a somewhat similar scheme to establish co-operation between cities that the duplications and needless and costly experimentation may be eliminated. One of the most successful experiments has been tried out in the State of New York, where an institution known as the Bureau of Municipal Information has been established, the first agency of its kind in the world, an institution of and for the cities of the state it serves. It is controlled absolutely by the cities and is supported only by them, so that no influence is felt from vested interests, political parties, individual cities or groups of citizens; in other words, it serves every state official unbiasedly and impartially. The object of this Bureau is to collect facts and supply them for the use of city departments in formulating correct plans for their work. It has established a co-operative relationship of all the cities of the state and keeps in intimate touch with every official, bureau and department. Without detailing the systems used or the extent of the field it covers, it is sufficient to state that the chief function is to supply information about any municipal problem to any state city official requesting it.

* * *

The results attending this experiment have proved almost beyond expectation. As a result of this co-operative plan, each city represented by the Bureau is deriving a needed service which it could not possibly duplicate by individual effort for the same money. The Bureau is able to get information about the cities and city problems more quickly, accurately, easily and economically than any individual municipality. This has been clearly demonstrated in numerous instances where specific data was desired. The departmental authority need no longer grope in a mass of perplexities in an effort to solve intricate problems. The ways and means used by other officials are at his entire disposal. Such a Bureau demonstrates the effectiveness of co-operation in municipal government and, by a systematic organization, makes for better management of municipal affairs without, at the same time, detracting from the individuality of the city or any of its departments. The success of this unique experiment has proved conclusively that a central clearing house of municipal information is a necessity for efficient civic operation.

Broadening the Scope of the Canadian Society of Civil Engineers

THERE is one big question before all Canadian engineers and technical men to-day—organization. We believe this fact is generally recognized and admitted. Perhaps no more definite proof of the unsettled condition of engineers' minds can be found anywhere than in the changes that are now taking place both in sentiment and personnel in the Canadian Society of Civil Engineers. It is felt by a large percentage of the members of this society that their name is a misnomer—either the name must be broadened to correspond more nearly with the avowed scope of the society, or the scope must be narrowed. This matter is now under discussion practically all over the Dominion, and the very fact that this discussion is long drawn out is perhaps the best proof that the solution is not easy.

It is generally understood that primarily the Canadian Society of Civil Engineers was intended to include all types of engineers. However, in those days, electrical, mechanical, chemical and mining engineering were merely in their infancy, and, this being the case, the management of the parent society naturally devolved upon the civil engineers proper, who, as a profession, were fairly well developed and organized. The infants grew up, however, as infants will, but, as often happens in domestic life, the parent continued to think of them still as children and failed to give them a proper voice in the management of the business; failed to take them into partnership. The inevitable result followed—the young ones left home and started up in business for themselves.

So to-day we have in Canada, in addition to the parent society, a number of more specialized organizations—the Canadian Mining Institute, the Chemical Society of Canada, branches of the American Societies of Mechanical and Electrical Engineers, all more or less technical and eligible, for the most part, for membership in the parent society but divorced from it largely through lack of parental sympathy and recognition.

And now, at the eleventh hour, the parent seems inclined to admit that he has been a little arbitrary, perhaps, with his offspring, and appears ready to make overtures. It is not evident, yet, what the result can be. The younger societies are well established and growing rapidly. They have reached a position of independence where they can arbitrate. It is not, however, any feeling of independence or resentment that causes them to consider, very carefully, any movement back into the old organization. The fact is, their aims are different. It is as if the son of a manufacturer of machinery withdrew, for some reason, from his father's business and started up in the business of manufacturing shoes, for instance. There could never be any inducement for this father and son to combine their businesses for the reason that they are so entirely different, do not dovetail in any way, and this is the attitude, in a sense, of many members of the younger Canadian societies, when the question of going back into the parent organization is broached.

* * *

There seem to be at least two general courses that may well receive consideration at the present moment. The first is the change of the name of the C. S. C. E. by dropping the word "civil" and so changing the constitution that there could be included, within one big organization, civil, electrical, mechanical, mining and chemical sections on an absolutely equal basis. That would presuppose, of course, the acceptance into membership in the new society of all the members of the various sections, and many of these members are not technical men in the sense in which this term is usually accepted. Would it be possible, or, if possible, would it be desirable, to so constitute any one organization that it would be acceptable to so many varied interests?

The other suggestion is based on the realization that technically trained men have, to-day, a double interest in life, the first—professional—the second—national. For strictly professional purposes classification into smaller units seems to be the most useful and effective. For national aims the organization may well include not only engineers and technical men, but all men whose interests or instincts or training bring them into intimate contact and sympathy with technical men and whose ideals would be, in general, the same. This suggestion, then, leads along another line of thought—that the present societies retain their identity and independence in all matters pertaining to their own particular professional work, and that a general organization, including the members of all the independent societies, and governed by a central body including representatives from all the independent societies, be formed for national work in which all are equally interested.

It is safe to say, we believe, that this matter is receiving the careful thought of the majority of our various societies to-day, and that they are considering it with an open mind. A conclusion reached on this basis will bring unity of action. And united action among engineers and technical men generally could solve for us many of the national problems which clog our progress while we, as yet, sit hopeless and helpless.

War Activity of Canadian Technical Men

The extent of the activity of Canadian engineers in the great war is reflected from the figures given out by the Canadian Society of Civil Engineers. From a membership of slightly over three thousand, 716 have enlisted. These men are to be found in practically every branch of military service, but are performing their greatest service in building railroads, bridges and other engineering operations. The engineers enlisted comprise nearly 25 per cent. of the total membership. Of this number thirty-three have been killed or have died of wounds. Twenty-eight of the members have been decorated for conspicuous bravery under fire. No other single body of men has a larger part to play in the material and economic development of Canada than the Society. Town planning, civic improvements, transportation by rail and highway are a part of its scope, but in the utilization of our natural resources, upon which the future of Canada so largely depends, will the measure of the engineer's importance, to a country such as Canada, be felt the greatest.

In connection with the members who have enlisted, it has been decided to prepare an honour roll, and its unveiling will be made the occasion of a special ceremony at the rooms of the Society in Montreal.

The annual report of the Joint Committee of Technical Organizations will be presented and discussed at a general meeting of technical men on Friday evening, March 30, in the Chemistry and Mining Building of the University of Toronto. Everyone who is associated in any capacity with engineering or technical work, whether himself a technical man or not, is earnestly requested to attend this meeting.

Constructional Details of Big Aqueduct

Fourth Article of the Series on Winnipeg Water Supply Covers Excavation and Backfill Methods on Contracts 32, 33 and 34

By A. C. D. Blanchard*

THIS article is the fourth of a series of six articles dealing with the construction of the 85-mile concrete aqueduct section of the Greater Winnipeg Water Supply. The first and second articles, which appeared in the Feb. 28 and March 7 issues of this magazine, deal with the general features of the undertaking and the contractors' organizations. The third article, which appeared in the March 21 issue, deals with the excavation and backfilling on contracts Nos. 30 and 31. It is intended in this paper to discuss generally the methods adopted by the contractor in carrying out the excavation and backfill involved in the construction of the easterly 47 miles of aqueduct covered by the Greater Winnipeg water supply contracts 32, 33, and 34. These three contracts were undertaken by one contractor, the Winnipeg Aqueduct Construction Company, of Winnipeg, and the work is being carried out under a uniform method of construction, varied in detail only according to the depths and types of ground encountered.

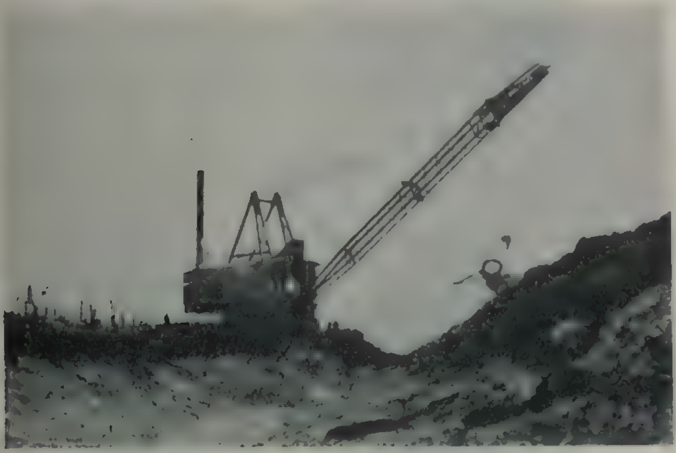

Fig. 1—This trench is about 12 ft. deep and 60 ft. wide at the top. The class No. 24 dragline has a bucket capacity of 3½ cu. yds. The spoil bank appears some distance away on each side of the trench.

The most striking feature of the country in which the location was finally made is an almost ideal flatness, permitting uniform gradients and tending toward a uniform method of construction. The structure was therefore planned to be built throughout by the ordinary cut and cover method. The depth of cut does not exceed 24 feet at any point, and the average is less than 10 feet.

Local Difficulties

Such conditions, while ideal for location, presented many peculiar local problems in excavating, as the extreme flatness of the ground surface immediately suggested problems of drainage on a large scale. Deposits of quicksand and other fine sands were shown by the preliminary borings to exist in large areas, the remainder of the subsoil consisting of clays of various hardness, with occasional outcroppings of solid rock. Surface water held by flat muskegs occurred over a considerable portion of the route.

Construction commenced early in 1915, and the work was attacked at six points at intervals of six or seven miles, and a total of 12 miles of excavation was done. The drainage of the large muskeg through which the summit cut near the intake was to be made was also undertaken with a small gasoline land dredge, with excellent results. The season of 1916 saw the opening of two additional camps near the easterly end of the work, and a start made in the construction of the deepest, heaviest, and largest construction along the entire line.

Excavating Machinery

The principal excavating machinery in use by the contractor consisted entirely of Bucyrus drag-line excavators ranging in size from 30 to 125 tons and in boom length from 45 to 110 feet. The largest machine has a dipper capacity of 3½ cubic yards. These machines, of which there are ten all told on the three contracts, are of the most modern type, the larger ones being equipped with searchlights and electric lighting, operated from power produced by steam turbine generator units. (See Figs. Nos. 1 and 2.)

All the excavators are mounted on structural steel bases, to which are attached heavy timber shoes or runners, and the distribution of pressure upon the soil (which in many places is extremely soft) is obtained by the use of large timber pads or platforms in sections, which are swung from rear to front by the machine as it moves ahead. Portable rollers are maintained between the shoes and pads and kept properly spaced by the workmen. Locomotion is secured by throwing the bucket ahead and gripping the soil, the buried bucket being employed as a deadman. (See Fig. No. 2.)

The machines have proved their suitability for the work, and have been found to operate successfully in ground varying from the hardest clay to the softest bog. The intensity of bearing pressure is maintained below 200 pounds per square foot.

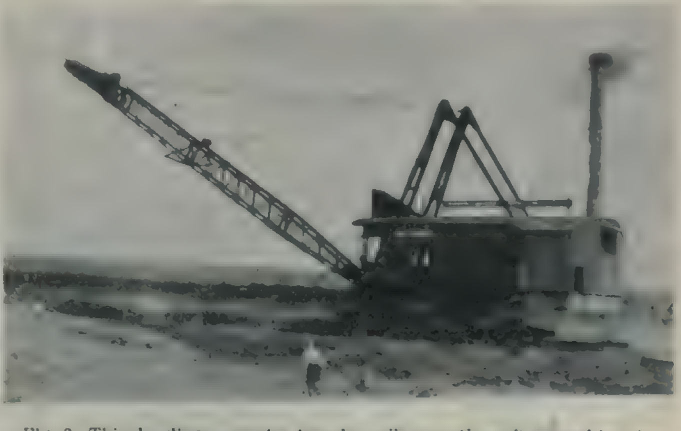

Fig. 2—This dragline excavator travels easily over the soft ground by platforms handled by the machine. Note also the shoes and rollers. The swinging circle of the machine is 24 ft. in diameter.

Perhaps more than any other feature the length of throw of the boom is the most distinct factor in the success of machinery designed for excavating under actual conditions encountered on this work. In several large areas the subsoil at grade is a very soft clay, and without ample provision for a wide berm and distribution of spoil over a comparatively large area, the trench bottom would be in great danger of squeezing or heaving.

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* Division Engineer.

Drainage Measures

As previously remarked, one of the most fundamentally important considerations is adequate and thorough drainage. This principle must be applied prior to the advance of the masonry construction and preferably ahead of the main trench excavation. When the District railway was constructed in 1914 a number of offtake ditches were excavated to carry off the water collected from the railway side ditches. This system of railway drainage did much to better the general drainage conditions along the whole line, and it was only necessary to supplement this work by a few other ditches for the aqueduct construction.

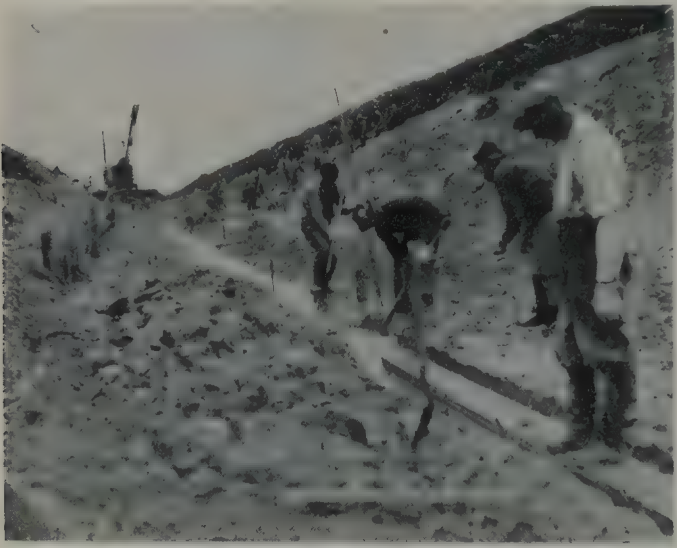


Fig. 3—The preparation of the foundation for inverts after the excavator has passed is an important factor.

In consequence of these operations the contractors' problems as regards drainage were confined, to a great extent, to local pumping, to keeping the surface water entering the trench down to a minimum, and to handling the ground water resulting from springs and seepage within the trench itself. The handling of surface water is fairly successfully accomplished by digging small ditches by hand and by obstructing or diverting the natural flow of water by means of continuous spoil banks, placed by the excavators. The troubles occasioned by water within the trench would naturally be lessened by keeping the trench excavation just ahead of the concrete work. This involving a partial delay to the excavating outfits, the contractor prefers to handle additional water if by that means he could complete his season's excavation in time to utilize his machine for backfilling over the completed structure. The pumping equipment is, therefore, of considerable proportions, and consisted of a large number of portable gasoline-driven units, ranging in size from two to six inches discharge. These pumps are mostly diaphragms and centrifugals, and are placed at frequent intervals in the trenches, lifting the water into convenience offtake ditches at the surface. Drainage of small portions of the trench prepared for receiving inverts is provided by wooden box drains under the centre of the inverts and leading to pumps at intervals of a few hundred feet. As a guarantee against damage to freshly-laid invert concrete, the contractor in many cases provides duplicate pumping outfits.

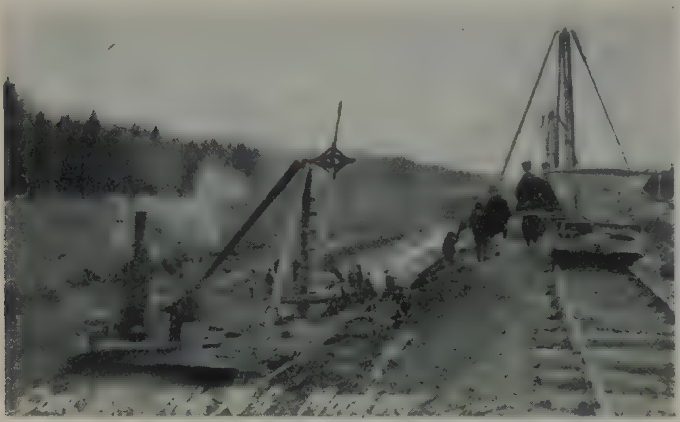


Fig. 4—Removing excess material in trench by hand excavation, supplemented by small derrick.

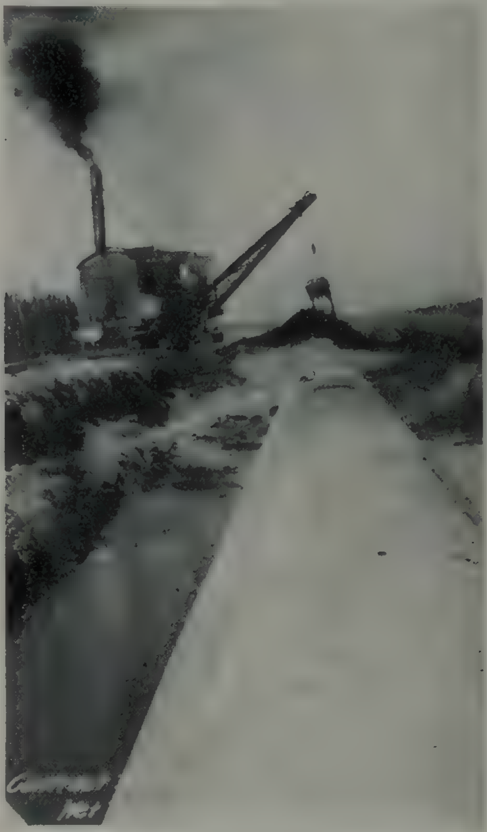


Fig. 5—Backfilling over completed concrete aqueduct; first, four feet of hand-packed backfill is placed, then the machine backfill is deposited.

Preparation for Invert Concrete

Ahead of the concrete work, the trench, as roughed out by the drag-line, still requires considerable treatment in preparing it for the reception of the invert concrete. The accumulation of material which has washed in from the sides of the trench has to be removed, as also the material left by the drag line for final trimming. This work is carried out largely by hand labor, supplemented with small derricks operated either by hand or by means of gasoline engines. (See Figs. Nos. 3 and 4.) The progress of this trimming is one of the important factors that controls the possible rate of advancement of the work.

The invert bottoms are taken out to templet, and are prepared finally just prior to the placing of the concrete. No difficulty is experienced where clay is encountered as a foundation, but if quicksand occurs, slightly different methods have to be adopted. The bottom is then taken out level and slightly below the concrete lines, and the foundation is brought up to grade by placing screened gravel over the quicksand, tamping thoroughly, and providing drainage in the centre by means of the small wooden box drain previously mentioned. Concreting over this foundation can be safely undertaken within a day or so after its preparation.

Backfilling Methods

The placing of the refill or embankment over the completed concrete work is carried out in two stages. Selected material is first placed and tamped in layers and carried up four feet above the invert level. The balance of the backfilling is done by machine, and for this purpose the excavators are brought back, after completing the trench excavation required for the season's work. In placing refill the machine travels along near the edge of the trench and replaces such soil already excavated as is required to bring the backfilling up to the required lines. (See Fig. No. 5.) In general the backfilling is required to be left at the completion of the contract at a minimum height of four feet over the crown of the arch. Where shallow trenches exists it is necessary to do considerable borrowing from the sides. In the deep cuts the excavated soil furnished ample quantities for refilling. Borrow where needed is obtained by making continuous shallow excavations parallel to the aqueduct, always a sufficient distance away to provide a safe berm outside the lines of the earth work.

Top Soil as a Surface Dressing

Provision is made for the removal and storage of the top soil from the trench excavation, and this material is segregated, to be afterwards replaced as dressing on the surface of the embankment. Where it is deemed expedient, seeding is proceeded with during the season following the placing of the backfill, thus safeguarding the top soil as a dressing and providing a neat appearance to the finished work. In the settled country the borrows are also seeded and the accumulation of noxious weeds prevented. The finished structure thus presents a pleasing appearance to the observer, as it is made to harmonize with the surrounding landscape in such a way as to be least noticeable.

Grand Pabos Pulp Mills

Successful Concrete Construction Carried Out During Extreme Winter Weather—Increased Cost Offset by Saving in Time

THE recently completed Grand Pabos mills of the St. Lawrence Paper & Lumber Corporation is a very remarkable example of how reinforced concrete construction can be carried on successfully during the extreme Canadian winters. This big job was begun late in the summer and continued right through the winter with hardly a let up. The Aberthaw Construction Company, of Boston, were the contractors.

The special methods used during the cold weather were essentially similar to those recommended by the Portland Cement Association in their recent pamphlet, "Concreting in Winter." The aggregate was heated by steam before being mixed and the freshly poured concrete was kept from freezing by canvas covers and the heating of the building interiors with the usual salamanders. Although the greater part of this big job has now been completed long enough to show any defects which might be caused by improper work during cold weather, no such defects are visible; in fact, all the winter work has proven to be exactly as good as that done during other periods of the year.

An Extensive Plant

The Grand Pabos Mills are larger than appear in most of the pictures or than is evident from a casual inspection of this interesting plant. This is due in part to the fact that many of the buildings are of one-storey and are located on the slope of the hill. The entire plant, however, occupies a tract 900 feet east and west, and 700 feet north and south. The present plant contains some twenty buildings, among the most important of which are the digester house, four blow pits, screen room, acid plant, bleachery, paper

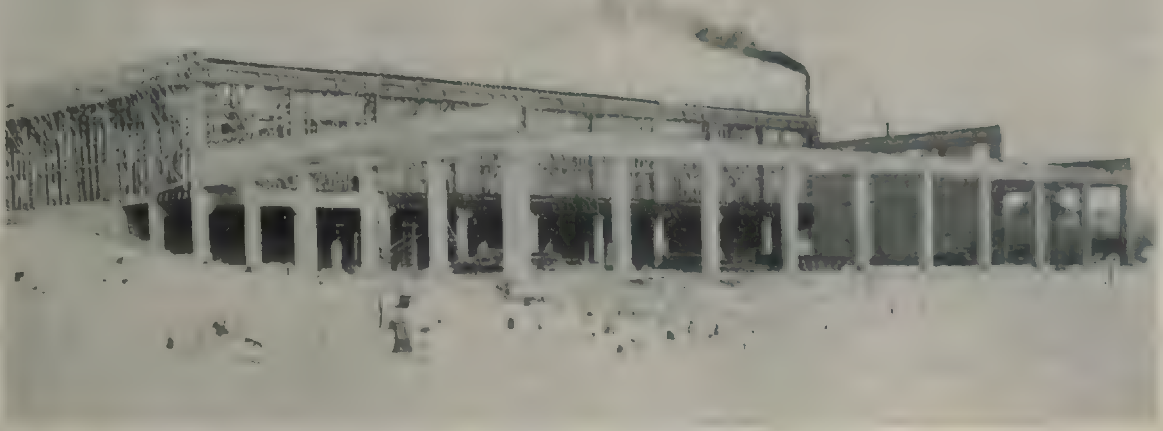


Fig. 1 -The Grand Pabos mill of the St. Lawrence Pulp & Lumber Corporation, showing pulp storage building in foreground. and office, repair and supply shops in the rear.

machine room, pump storehouse, supply and repair building, electrolytic plant, boiler and engine room, shipping room and wood room. There is also a 30,000-gallon tank with its bottom at an elevation of 180 feet above the bay, for fire protection purposes.

This company controls some 500 square miles of territory, from which wood pulp is being cut. The mill receives this both by water and by rail, the company owning a private railroad running into the lumber region. The finished product of the mill can also be shipped either by rail or water. The importance of this plant at the time construction was begun, as now, was so great that it seemed advisable to push construction right through the winter, and the contractors have demonstrated beyond any reasonable doubt that concrete work can be carried on during freezing weather just as at any other time of the year.

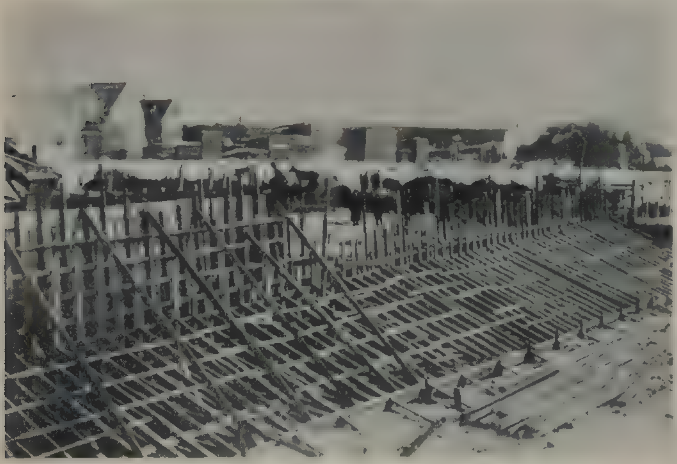


Fig. 2—Working on retaining wall on north-western side of pulp storage building during January.

The officers say that while the cost of winter work is necessarily somewhat more than that during the warmer months of the year, the increased cost is not at all proportional to the saving in time on such jobs as the Grand Pabos Mills described here.

Programme of Canadian and International Good Roads Congress will be Practical

THE programme of the Fourth Annual Canadian and International Good Roads Congress, to be held at the Horticultural Building, Lansdowne Park, Ottawa, from April 10th to 14th inclusive, has been arranged to cover a wider and more practical field than any of the three preceding conventions held under the auspices of the Dominion Good Roads Association. It is aimed to make the papers and discussions of practical value to all who are interested in good roads, technicalities being avoided as far as possible. The morning sessions will be devoted almost entirely to the consideration of rural road problems, with an avoidance of technical terms, while the afternoon sessions, though dealing largely with urban street methods, and involving technical descriptions to a certain extent, will be within the comprehension of the lay delegates. Experts from the United States, as well as those belonging to the Dominion, will deal with the various subjects. Amongst these may be mentioned Mr. Paul D. Sargent, chief engineer of the Maine Highways Commission, who will treat of modern methods of constructing and maintaining gravel and macadam roads, on which subject he is an authority; also Col. W. D. Sohier, chairman of the Massachusetts Highways Commission, who will take up the question of road surfaces from the viewpoint of traffic requirements. Prof. Blanchard, of Columbia University, New York, another United States authority on matters pertaining to road work, will describe the best and most economical methods of surface maintenance with road oils. A paper on brick pavements will be read by Mr. D. T. Black, city engineer of Welland, Ont., and Mr. T. Harry Jones, city engineer of Brantford, will present one on concrete pavements for city and country roads. Mr. W. G. Yorston, road commissioner for Nova Scotia, will deliver an address, and Mr. Thomas Adams, of the Dominion Conservation Commission, will deal with the subject of roads in their relation to town planning. Mr. R. B. Morley, secretary of the Ontario Safety League, will also speak regarding the work accomplished by that body. An important paper will be that by Mr. L. H. Reineck, of the Geologic Survey, Dominion Department of Mines, who will take up the subject of the location of deposits of road materials throughout the country. In all some eighteen papers will comprise the programme, while about sixty engineers and road builders of standing have been invited to lead in the ensuing discussions.

The governments of Quebec and Ontario will both be represented by cabinet ministers and officials. From Ontario are expected Hon. F. G. Macdiarmid, Minister of Public Works, Mr. Geo. S. Henry, M.P.P., and Mr. W. A. McLean, Deputy Minister of Highways, ex-president of the American Road Builders' Association, and past president of the Dominion Good Roads Association. Mr. McLean will give an address, supplemented with an exhibition of slides showing French road scenes. These will be doubly interesting, not only as illustrating France's road system, but also as showing localities over which fighting has occurred. Serious illnesses have prevented Mr. McLean's attendance at the last two congresses, and his presence will be much appreciated at the coming convention. The Quebec Government will be represented by Hon. J. A. Tessier, Minister of Roads, and Hon. Walter Mitchell, Provincial Treasurer, and Mr. Mitchell will speak on road finances. Mr. B. Michaud, Deputy Minister of Roads for Quebec, and road engineers Henri, Fafard and Fraser will also take part in the proceedings. The official representative of the Dominion Government has not yet been designated, but it is expected that the importance of the good roads movement will be recognized by the participation of one or more high personages. Archbishop Gauthier and Bishop Roper, of Ottawa, have been invited to attend the opening session.

The provincial road associations will also have official delegates in attendance. These will include Mr. S. L. Squire, honorary president of the Ontario Good Roads Association; Mr. C. R. Wheelock, the new president of the same organization; and Mr. Fred G. Pearson, president of the Nova Scotia Good Roads Association.

The exhibition of road-making machinery, to be held in conjunction with the Congress, will be the most complete yet assembled in Canada, It will include exhibits of machinery for highways and streets, road materials, engineering instruments, equipment, municipal improvements and government road models.

Cost Accounting for the Contractor

Its Relation to His Organization — Data Should Not be Concealed if Good Results are Desired—Five Essential Features of a Cost System

EVERY contracting organization must have a cost system of some sort, however crude. A hit-and-miss plan never works successfully. Any cost system, however, is valueless unless used by the entire organization, and a contractor who is not prepared to make his costs open and accessible is almost as well off without a system at all. This idea was brought out by Leslie H. Allen in a paper read at the recent meeting of the American Concrete Institute. His paper, abstracted below, discusses the essential features of a good cost system for contractors and shows how such a system may prove of valuable benefit.

A system of cost accounting to be of any value to a contractor must have its data accessible to and understood by everyone in his organization who has anything to do with costs. It is valueless if it is kept a secret. A proper system of cost accounting may be likened to an expensive tool or machine—of great value when working, but an unjustifiable expense if kept idle most of the time.

The contractor who thinks that his unit costs are a trade secret and that the circulation of information regarding his costs will do him an irreparable injury is making a great mistake. If his costs are higher than his competitor's these competitors will lose business if they use them. If his costs are lower competitors will lose money if they use them. It is efficiency and not cost data that makes for low costs. The cost data simply point the way to efficiency and show the failures to reach it. For this reason the writer's firm has not hesitated to make public its costs at any time. We feel that if we make lower costs than our competitors it is because we have the men and the brains needed to do it. Others cannot equal our costs simply because they know them. On the other hand, if our costs are higher than they should be no one gets from their publication any valuable information that can give them an advantage.

Cost System Stimulates Interest in Work

Very many contractors have the labor costs distributed by a timekeeper and worked up in his spare time by the bookkeeper, and the results are only seen by the boss. Neither man understands his work or can show any enthusiasm for it. The opposite of this is the case on our work, and it is sometimes quite embarrassing to the writer to be called upon to adjudicate in cases where knotty points are being discussed with great earnestness by our timekeepers and foremen, such as whether repairing forms damaged by the strippers should be charged to stripping, erecting, or making. The fact that such interest is shown in minor points indicates a real interest in efficient work and low costs all down the line.

The concealment of cost data is one of the reasons why it is so difficult to get accurate results. No employee can take intelligent interest in work which is meaningless to him. The contractor's problem in any system of cost accounting is not to so conceal the costs that no one but the boss can get them or understand them, but to make them accessible to and understood by the greatest possible number of people in his organization. The more people he can educate to understand cost analysis in his organization, the more intelligently and sensibly is his work going to be handled. Not only this, but it is very desirable that the architect or engineer should have some idea as to the costs of the work being done by the contractor under his direction.

Cost Scheme Saves Money

There occur to the writer's mind incidents on construction work performed by his firm where the engineer's knowledge of what the work was costing has led him to allow modifications in the design which have saved much money for clients, whereas if the cost accounts had been concealed suggestions and arguments regarding a change in the design would have gone unheeded. For instance, on a recent job where the depth of column footings varied, owing to bad ground, the engineer desired to build all footings the same thickness and to start all columns at the same height and to make up the different depths between top of footing and bottom of column by pyramids of concrete, each one of which, of course, would need separate forms of varying shapes. Instead of arguing on a matter of opinion we were able, after building two or three, to demonstrate that this method was much more expensive than putting additional concrete into the footings, and we were allowed to make the change.

There are five essential features of a contractor's cost system:

First, the estimate.—(a) An estimate for each job is made, based on the costs of earlier jobs of similar nature. (b) This estimate should be analyzed to show first the quantities, unit costs, and total costs of each item of labor, and then the quantities and estimated prices of each item of material and each subcontract.

Second, a daily labor cost report showing the labor costs of each day's work.

Third, a weekly labor cost report showing in parallel columns the estimated and actual quantities, unit costs, and total costs of the work performed.

Fourth, a monthly statement of the cost of materials and sub-contracts purchased or ordered, showing in parallel columns estimated and actual costs.

Fifth, a final summary made at the close of the job showing the total cost of all labor and material.

Estimate a Source of Valuable Information

In many offices the estimate is locked up in the safe the day the contract is signed, and never sees the light of day again. The estimate is, or should be, the result of the estimator's study of cost data on preceding jobs, and is therefore the standard set for the cost of the job for which it was made. With it daily labor costs and material purchases should be compared. It contains much valuable information that is most useful to, and should be made use of by, the contractor's force. In order that it may be of the greatest possible use it should be in sufficient detail to show in separate items the various kinds and classes of work done by different gangs, and it is best to make an analysis of the estimate into two main divisions:—Labor; material (sub-contracts and all items not classed as labor). The total of the first division therefore gives the estimated total payroll and shows how it is expected that this will be spent upon carpenters, masons, laborers, etc. The second division shows in detail the quantities of material, sub-contract work, etc., item by item.

Who should see and use this valuable information and work to these standards?

First, the general superintendent, as it gives him a standard of performance by which he can measure his job superintendents and foremen. It tells him more in a few minutes about the supply of materials and sub-contracts than would a day's studying of the plans, and in general is a big help to him in supervising the employment, supply of material, progress, etc.

Second, the job superintendent needs more than anyone to see the estimate. From it he can see what the firm expects him to accomplish in the way of costs and his criticisms of the estimate should prove helpful to the estimator. With it he can confer with the purchasing agent of the company and with the local dealers from whom he has to buy supplies and without a lot of computation on his part he can place the orders for much of his material. From the subdivisions of the analysis he can determine the sort of organization that should be placed upon the work, how many carpenter foremen, how many carpenters, the size of the labor gang, the number of mechanics, etc. Reading the estimate will call to his mind all the work that has to be done. The estimate shows him the quantities of materials he has to receive and he can plan for their efficient storage.

Third, the purchasing agent. From the material section he prepares a more detailed schedule and by taking dates from the progress schedule he can prepare for his own use a list showing all materials required and the dates required in order that he may start in buying intelligently and see that everything is delivered on time. He has a valuable check on the bids received.

Fourth, the scheduling men also should receive the material section of the estimate and check their quantities by it. From the purchasing agent they receive notice of the dates these schedules are required in order that he may buy them and have them delivered at the job in time.

Fifth, the foremen of brickmasons, carpenters, concrete gangs, etc., should be told what are the estimated costs of their work, and shown from week to week how their work compares with the estimate.

Daily Labor Costs Effective

The second important feature of a cost accounting system is a daily report of the labor costs. These are best prepared on the job and should be in the job superintendent's hands by 9 o'clock the next morning. If each carpenter foreman is told what are the estimated costs on the operations he is performing and is notified every day as to whether he is keeping within or overrunning his costs, it is sure to have its effect. We frequently plot the principal items graphically on a chart which not only the foremen but the workmen can see as they check in and out. The lowest laborer takes a cheerful and even enthusiastic interest in the vagaries of the wandering line that shows the cost of the work he is doing.

It is best to keep the cost accounts on the job instead of in the head office. Costs to be of any use should be fresh, not stale. If the superintendent knows at 9 o'clock the very next day that concrete costs 20 cents a yard more to put in than on the preceding day he can talk it over with his foreman while the matter is fresh, and investigate and remedy the fault; but if the news does not come to him until a week or ten days after the work in question is done, it is too late to do anything. It is not necessary to have these daily cost reports go through the main office in any case, as they come in too often and contain too great a mass of detail to be of much benefit to the general superintendent. The daily costs point out to the job superintendent an occasional high spot that he has missed, and are an unfailing barometer of the job.

Weekly Labor Report

The third essential of a cost system is a weekly labor report. This should show in parallel columns the estimated and actual quantities, unit costs, total costs, and saving or overrun. The amount of detail may vary in different organizations but should be sufficient to give an intelligent account of the operations. This statement should be furnished to officers of the company as well as to the job superintendent. For the benefit of the former the main facts can be condensed into a very few items by the use of a simple summary. This statement gives a sort of review of the job's operations to date. It should go to the general superintendent and the estimator in the head office. The latter particularly needs to know the fluctuations in costs in order that he may check up his judgment with actual facts and learn the costs of any new sort of work.

Monthly Labor Costs

The fourth essential feature of a cost system is a monthly report showing in tabular form the estimated and actual costs and quantities of the materials, and amounts of sub-contracts and other expenses incurred. By adding together the savings or overruns on the labor and materials the contractor can tell every month just how far behind or ahead of estimate his job is, and can make an intelligent forecast as to how much can be saved or will be lost on the remainder of the job. Such information is rarely to be found in a contractor's office, but is of great value to him, and in itself is worth almost all the time and expense that should be put in on a cost accounting system. This statement should, of course, go to the job and general superintendents who are using the materials, to the purchasing agent who spends the money, and to the estimator who finds it a most valuable check in his work.

Final Summary Gauges Future Work

The fifth essential feature is a final summary of the job costs made up in the same form as the original estimate, which should be filed for future use. A copy should be given to the job superintendent as a record of what he had accomplished, and to the general superintendent as a permanent reference for him, in order that he may have something to judge by in his criticism of future jobs. The estimator should have a copy, as it is his chief authority for prices he places upon new estimates.

Grain Elevators in Western Canada

Handling Grain on a Co-operative Basis by Largest Elevator Company in the World — Description of a Standard Building

By W. A. S. Napier

THE growth of the Saskatchewan Co-operative Elevator Company, Limited, has been little short of phenomenal. It organized its first "Local" in 1911, and in that year built 47 elevators. To-day it owns 261 elevators and is known as the largest elevator company in the world.

This company seems to have made a special study of the farmers' needs and has developed its business with this object in view. A visit to any one of its elevators will readily confirm this statement and show that everything has been done for the handling of the farmer's grain to his complete satisfaction.

There is a construction department at the head office which is responsible for the building of elevators and the upkeep of existing ones. Plans and specifications are prepared there, and, as soon as climatic conditions allow, working gangs are sent out to the various centres at which elevators are to be built. Thirty new elevators are to be built this spring and the preliminary work is proceeding rapidly. A short, technical description of the main building features will be of interest.

A Standard Elevator

The foundation is of concrete and consists of six piers, 3 ft. x 11 ft. x 3 ft. high resting on a concrete mattress 11 ft. x 32 ft. x 12 ins. All the piers are connected at the ends by a 12-in. concrete wall and reinforced with ¾-in. twisted steel bars. The top of the piers is covered with two thicknesses of 2 in. x 6 in. and capped with 8 in. x 12 in. x 10 ft. sill timbers, upon which rests the 3 in. x 12 in. floor joists and 8 in. x 12 in. wall timbers, which receive the 2 in. x 4 in. crib wall. The floors of the main bins are made from 3 in. x 12 in. joists covered with two thicknesses of common boards, and these, in the working part of the elevator, are made from 3 in. x 8 in. joist, and one thickness common boards and one thickness 6 in. D and M flooring. The exterior of the elevator is covered with 6 in. bevel siding and roofs with cedar shingles. Special

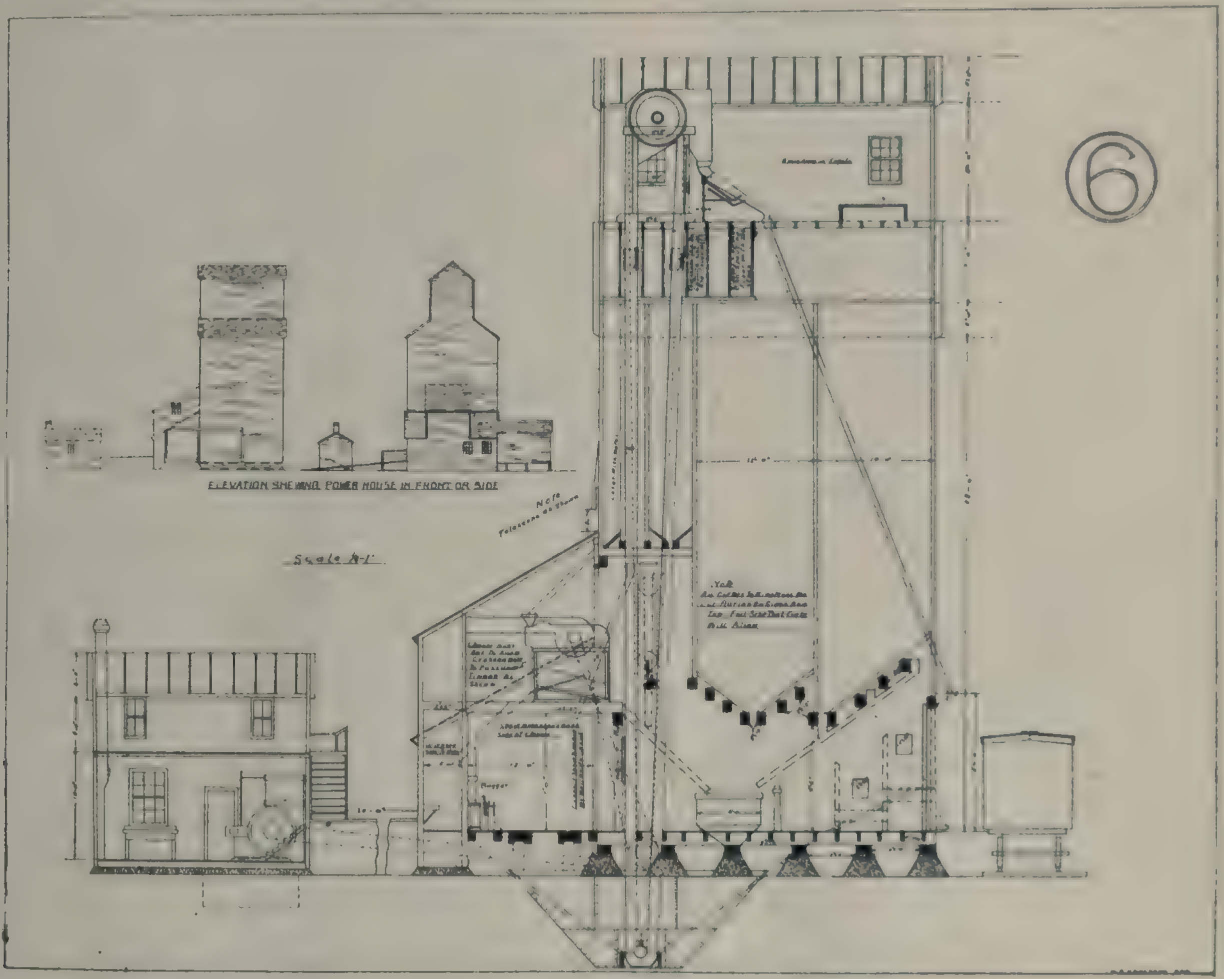


Fig. 1.—Interior working of Elevator with arrangement of special bins, also exterior view showing power house in front and side.

attention has been paid to driveway and approaches, the enclosed driveway being 12 ft. x 56 ft. with a 4 ft. x 18 ft. scale bay, the gradient to approaches being ¾ in. in 12 in. or less and not less than 12 ft. wide.

Special Binning

A main feature is the attention given to special binning, particularly in the construction of later elevators. In this connection it is interesting to note that special binning was considered by many of the line companies as obsolete, and that any company who favored such a system was courting trouble. The fact that 75 per cent. of the grain which passes through this company's elevators is special binned testifies to the popularity of the venture. There are twenty-one bins with one cleaner bin, sixteen holding 1,500 to 1,600 bushels with four centre bins holding 1,000 to 1,200 bushels and one bin for cleaning seed grain, having a total storage capacity of 30,000 bushels. In order to utilize space the cleaner has been moved to a position over the driveway. Its former position over the hopper scale interfered with the new bin arrangement instituted.

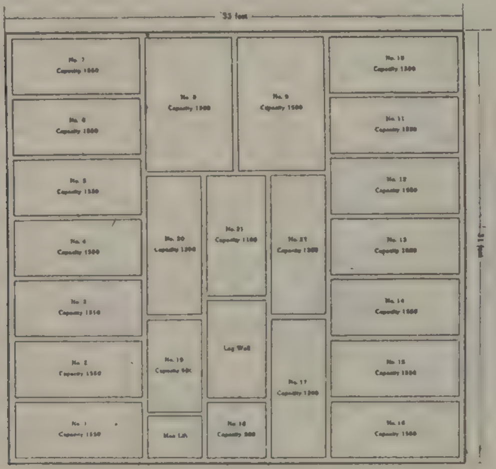


Fig. 2. Arrangement of bins and capacity.

Neither the farmer nor the company can attach too much importance to the weighing of the grain. Great care has to be exercised and the best possible equipment used both in weighing in and weighing out. There are two scales, one 1/6 ton 16 x 8 platform dump scale for weighing the grain on receipt at the elevator, the other a hopper scale, capacity 100 bushels, for weighing grain before loading from bins.

After the grain is weighed it is dumped into a receiving pit, all pits being made with sufficient pitch so that grain will clean out without sweeping. By means of a hand lever the grain is directed into the leg, then elevated into the bin allotted for its use. Each pit is protected against moisture by the use of a heavy steel pan, 24 ft. long by 9 ft. deep.

Elevating and Loading

All the elevators are equipped with two legs. These legs are furnished with 11-in. 4-ply rubber belting with 5 x 10½ buckets placed a foot apart. This equipment is of great benefit to the farmer, especially in the fall, when traffic is often congested. The two legs working together quickly clear the pit, thus saving valuable time, and enabling the farmer to dump his grain without unnecessary delay. They operate just as advantageously in clearing a bin into a car, which can be done in thirty-five minutes.

All the grain for storage is discharged from the legs into a Gerber spout which is regulated by a hand lever and dial on the main floor. This dial indicates the number of the bin the agent has allotted for the grain, and by adjusting the dial the spout can be so manipulated as to discharge the grain into the spout necessary to convey it to its allotted place.

To empty a bin a hand lever is used to discharge the grain into the spout, each bin having a separate spout, and each spout emptying into the hopper scale. The grain is then deposited into a pit from which the legs elevate it to the Gerber spout, which empties into a direct spout. This connects directly with the flexible spout used for loading the car.

Cleaning the Grain

Grain is cleaned by a No. 6 Monitor cleaner having a capacity of from 400 to 800 bushels per hour, according to the arrangement of screens, and is suitably equipped for treating all kinds of grain. There is also a kettle for testing grain (weight to the bushel) and a testing scale for dockage. Fire extinguishing apparatus is installed and every precaution taken to insure the grain from fire. The engine room, situated at the rear, is equipped with a 12 horse power Foos engine, combination gasoline and coal oil, which furnishes the motive power for working the elevator. Part of the engine room is used as an office. All materials used in construction are first class, and everything is done to secure the best available workmanship. Great care is exercised in building the bins to prevent any possible chance of leakage, all hopper bins being steel lined and made tight.

For solidity of construction, adaptability to the farmer's needs, and all-round efficiency it is believed these elevators cannot be surpassed. Every one built is a real investment to the farmer, and it should be a matter of great satisfaction to him to know that he can ship his grain to his own elevator, one in which he has a financial and co-operative interest.

Methods of Construction and Design Chiefly Responsible for Timber Bridge Floor Fires

MANY bridges are provided with wooden floor decks and driveways. Criticism is often directed against this type of construction on account of the apparent fire hazard. A writer in the Engineering News discusses the fire possibilities of timber floor decking, drawing his conclusions from an investigation of a fire on the McKinley Bridge at St. Louis, a timber-floored structure on which two fires have occurred within three months. The driveway of this bridge is constructed of 8 in. by 16 in. creosoted stringers over which hardwood slats, 1 inch thick, were laid on edge. A careful examination showed that in both fires the only portion of the driveway which burned to any great extent was the creosoted stringers, the hardwood slats immediately above the stringers being practically untouched. Investigation served to point out that the ignition of the timbers was facilitated by the condition of the driveway. Many of the slats are broken at the ends due to heavy traffic, so that numerous holes occur in some of them all the way through; in other cases only partially through. Many of these holes are filled with chips and slivers of wood, dry manure and other highly inflammable material, and it seems likely that the debris in one of these holes, after being ignited by a lighted match or cigarette stub, transmitted the fire to the stringers underneath. The fire was not caused from sources beneath the structure. After careful study of these two fires, the writer is of the opinion that the chief reason for the high fire hazard of timber decks is in the method of construction. The hardwood slat deck with the slats placed on edge is bound to tear and break. Slats placed on edge, under heavy traffic, afford the weakest possible resistance and can in no way be compared to the resistance offered by the same wood when placed so that the wear comes on the ends of the fibres as in the case of wood block. Where such slat construction is used, it should have a solid deck between the slats and the timber beams, and the slats should not be used as on the McKinley Bridge. A very much more efficient method of construction consists of building a solid deck and placing the regular creosoted wood blocks on this closed deck.

A number of recent fires on bridges with wooden beams and floors have brought out the criticism in some quarters that the use of wooden construction was not warranted on highway bridges. The writer has examined three such cases during the past year, and in every instance the fire was due not so much to the fact that wood was used as it was to the faulty construction. There is, of course, no gainsaying that untreated or creosoted timbers will burn when put under conditions where ignition is possible. This, however, is no reason for absolute condemnation of wooden construction. No structural material is perfect, and it is good practice in every instance so to safeguard structural materials that their various defects may cause as little trouble as possible. Where bridges are built of steel, the utmost care is usually exercised in keeping them painted with proper paint, so as to avoid rusting. In the same manner it is misuse of a good material, like timber, to use it where the chances are that it will not serve its best purposes.

In the fire referred to, the ignition was undoubtedly caused by sparks falling into rotten portions of the roadway and of the substructure. These more or less decayed parts glow and then set fire to the sound wood. The safe practice is to use only properly preserved stringers. This will effectually guard against any decay taking place, which is not only desirable from a strength standpoint, but from a fire-resistant standpoint. These stringers should then be properly protected against ignition from above, where the greatest danger usually occurs. Such protection can readily be given by putting on a solid deck and constructing the roadway of an approved type of creosoted wood block.

Whatever criticism is directed against the timber construction as a matter of policy should be directed against faulty construction and design rather than any inherent quality in the material. Properly designed and constructed bridges of timber construction have stood for many years without deterioration, and the occurrence of fires, such as the one herein described, should be regarded as the exception rather than the rule.

Montreal Theatre Being Rebuilt

The Princess Theatre, St. Catherine Street West, Montreal, is now being rebuilt with the object of converting it from an ordinary theatre into a vaudeville house. The plans are by Mr. D. J. Spence, of Montreal, and the general contractors, John Hayman and Sons Company, London, Ont. The owners are the Canadian Theatres Company, Limited, also of London.

The entire building will be remodelled, the only portion to be utilized being the stage wall. The rebuilding will increase the seating capacity from 1,300 to 2,500. The front portion will consist of the entrance, above which will be three storeys to be used as management offices, and in the rear will be the theatre itself, consisting of the auditorium, balcony and gallery. The main entrance and exit will be on St. Catherine Street West, while there will be three other exits, one at each corner of the building.

It is proposed to rebuild the side walls, removing one 6 ft. and the other 10 ft., which will make the theatre 16 feet wider; this also necessitates the rebuilding of the proscenium arch. The foundations will be of concrete, and the exterior of polychrome brick. The balcony and gallery are to be carried on cantilevers, so as to give a clear view of the stage from every point. The walls will be plastered on the interior, and a scheme of classical decoration carried out. The building will be as fireproof as it is possible to make it, the doors being calsomined and of fireproof construction, while the floors will be of concrete. No wood is to be used.

The plans provide for a marquee of wrought iron over the entrance. Staircases of marble and cement with iron rails lead to the balcony and gallery; these will be without bends, the object being to allow free access to the upper parts of the house and also to facilitate the exit of the seat holders. A large checking room will be placed near the ticket office on the auditorium floor. The boxes total 17, and will be reached either from the auditorium or from the balcony and gallery.

Retiring rooms, toilets and telephone room will be situated in the basement, and retiring rooms and toilets will also be on the balcony and gallery floors.

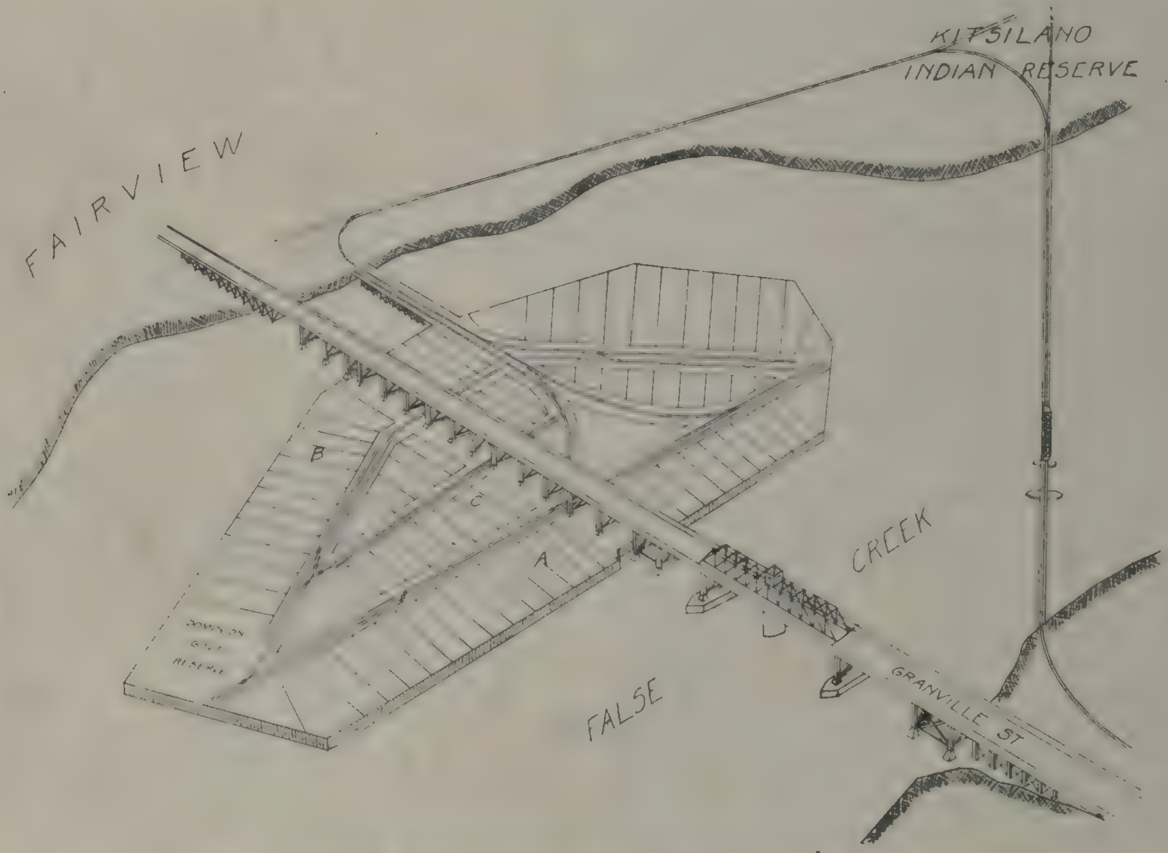
The lighting will be direct and indirect electric with a large central fixture in the ceiling and semi-enclosed lamps in the auditorium. A complete installation for producing mechanical lighting effects will be installed. The heating will be on the mushroom system, by which warm air is distributed under the seats. Ventilation by means of blowers will supply warm air in the winter and cold air in the summer. The fans will be placed in the roof, and the other heating and ventilating apparatus in the basement. The contract for the steel has been let to the Structural Steel Company, Montreal.

River water is filtered, refrigerated, and sterilized, then circulated through 12,000 feet of 1-inch galvanized pipe to 35 sanitary drinking fountains in the plant of the Atlas Portland Cement Company at Hannibal, Missouri, by a supply system recently installed at an expense less than the old system of supplying the workmen with cooled water in barrels. The sterilization of the water is one of the unique features of the installation. The apparatus utilizes the ultra-violet ray, as produced by a special mercury-vapor lamp, sending its rays into the water through a quartz tube. The new drinking water system, says the Journal of the Royal Society of Arts, reduced the expense and trouble connected with supplying the workmen with water and ice in barrels, at the same time giving the employees the benefit of a drinking water that is both pure and cold.

Practical Scheme of Vancouver Harbor Commission to Provide Cheap Industrial Sites

SINCE its creation by Dominion Government warrant, in September, 1913, the Vancouver Harbor Commission has been very much in the public eye. Ambitious plans have been drafted for the improvement of the harbor on the unit plan, the work to be spread over a number of years and to cost many millions of dollars, the assumption being that before the culmination of the great project the rapidly growing deep sea and rail trade of the port will have demonstrated the wisdom of adequate preparation. The stand taken by the Harbor Board relative to the major scheme of development has elicited some sharp criticism, none of which has been levelled at the first unit now approaching completion—the reclamation of a large section of Western False Creek tide flats for industrial sites. Concerning the wisdom and utility of this step there can be no difference of opinion. It is an open secret that in the past half-dozen years many promising industries have been turned away from Vancouver by the greed of owners of suitable building sites, and the enterprise displayed by the Commissioners will do more to attract a pay-roll quickly than has been accomplished by all other agencies in the last dozen years.

The area reclaimed by bulkheading and filling lies east and west of Granville street bridge, spanning False Creek, and bears the appropriate name, "Granville Island." Advantage was taken of dredging operations being carried out by the Pacific Dredging Company in the main channel to have the silt pumped into the bulkhead enclosure, which meant a considerable economy. The entire cost of the undertaking, including the south approach, water mains, railway tracks, roadways, light and power facilities, etc., will be approximately $300,000, or 14 cents per square foot, as compared with a cost of 16 cents per square foot for similar reclamation work carried out in Seattle.



Reclamation project in False Creek offers splendid industrial location.

The grant of land made by the government covered 42 acres, and the bulkhead has been constructed fifty feet inside this line so that when the timbers show signs of decay—probably many years hence—a permanent concrete wall may be built in units. A strip 33 feet wide has been reserved on each side of the bridge for the protection of the structure and to provide for increasing its width to meet the traffic demands of the future.

The total reclaimed is 1,443,407 square feet, or 33.13 acres. The quantity of fill material deposited was 971,457 cubic yards. The area between the inner and outer bulkhead contains 1.15 acres. The actual area available for industries is 28.2 acres, which has been divided into three zones as follows:

Zone A contains 11.24 acres, and is subdivided into 25 lots fronting on the main channel, with 20 feet at low water on the north side.

Zone B has 11.35 acres, subdivided into 28 lots, fronting on the south side, and when dredged will have 12 feet at low water.

Zone C contains 5.60 acres, subdivided into 26 lots. It is the centre, and will have no waterfront privileges.

The yearly rental will be, for Zone A, $1,500 per acre; Zone B, $1,000 per acre; and Zone C, $800 per acre. The scale of rentals was fixed by order-in-council last March. All leases are for 21 years, renewable for two more terms of similar period, making a total of 63 years altogether. The rent will be fixed for the first 21 years; at the end of that period they will be fixed for another term, and so again when the second period expires. This will give tenants something tangible in the way of fixity to work upon.

Altogether there are 79 lots in the reclaimed area, the majority being one-half acre. Already 43 lots (representing 16.089 acres) have been reserved, while applications not yet dealt with by the Harbor Board are more than sufficient to take up the balance. Among the enterprises already signed up are two contracting firms, two engineering works, sheet metal works, a coastwise steamship company, machine shop, etc.

The approach to the area is by means of a timbered roadway 80 feet in width laid on piles, which starts from the south side of the Creek, taking the location of the old Granville street bridge. It was originally intended that a solid causeway should be constructed, but the Department of Marine ruled that an open channel should be maintained in order to have a circulation of water as the tide ebbed and flowed so as to prevent the possibility of marine growth. The roadway is for combined traffic and railway use, the rails being laid flush with the planked surface. There are three streets running east and west through part of the Island, approximately parallel, and each will have flush trackage. The widest portion of the subdivision is just east of Granville street line, and it is here that the inner zone of lots without waterfrontage is located.

An area of approximately four acres of the eastern extremity of the Island has been reserved for Dominion Government purposes. A turning basin for vessels has been dredged just off this point.

The following quantities of timbers and lumber were used by the Harbor Board in carrying out the reclamation work:

	Feet.
Creosoted lumber	355,200
Creosoted piling	27,840
Cedar piles	30,243
Fir piles	31,340
Cedar lumber	190,556
Fir lumber	84,418
Total	719,597

Cast iron water mains 10 inches in diameter have been bent in the field to a radius of 50 feet, says Contracting. A cradle was built of old rails, pipe sections were placed in it, and a fire was built under them to soften the metal sufficiently to allow the pipes to settle to the required curve.

Sherbrooke's Development

In Industrial Conditions Shows Unusual Activity — Typical Instances of Expansion and Factory Extension

ANY one interested in industrial buildings could find a nice field for investigation in the city of Sherbrooke. This industrial centre of 22,000 population has experienced an unusual activity in this line of construction. A great deal of this expansion has been due to the manufacture of munitions, but it is not only the munition factories, in fact all lines of industry are kept specially busy. Manufacturers in Sherbrooke feel that at the close of the war it will not be long before those who are now busy making shells, etc., will find new lines to keep the wheels turning. There is a by-law at present before the citizens providing for the purchase of a water power by the city which after development will provide an additional 10,000 horse power. The mere presentation of this by-law shows a confidence in the industrial future of this city. The citizens are so well pleased with the success of municipal ownership of electric power in the past that there is little doubt that the city council will be authorized to buy the new water power. The following comparative figures showing the number of employees of the various classes of industries in 1914 and 1917 are significant.

Machine shop of the Canadian Ingersoll-Rand Co., Sherbrooke, P.Q., under construction

Industries	1914	1917
Metal Working and Munitions	1,050	4,830
Clothing and Textile	1,195	1,585
Other Industries	345	450

The Canadian Ingersoll Rand Company have increased their floor space over 200 per cent., making extensions to their buildings again and again. The extensions have been the same plan and style as their original plant, which consists of a series of one-storey buildings.

The main machine shop has now reached the large proportion of 200 x 525. This is of a steel and concrete construction, having reinforced concrete floor over the basement, on the mushroom system, with saw tooth roof. The design of the building is made to suit the large travelling crane which runs through the centre bay and which is fed from small cranes on the side bay. The cost of construction of this building for the last addition made was about $2.00 per square foot of floor space. The cost of this class of construction in 1911 was about $0.90, while the first addition made at the beginning of the war cost $1.65. All these additions were supervised and designed by the same architect, Mr. H. G. James, of Sherbrooke.

The MacKinnon, Holmes Company, who, like the Ingersoll-Rand, are working on munitions, built a splendid new factory last spring which was recently completely gutted by fire. This has been immediately replaced and some improvements made making it one of the most modern plants in Canada for steel construction work.

The Canadian-Connecticut Cotton Mills Company is just completing a new mill. This building is the very latest type of mill construction with cast iron columns, steel beams and mill hardwood floor 2 x 5 on edge. The American moistening system has been installed for the purpose of maintaining the necessary humidity for the weaving of the cotton fabric.

A few years ago the E. T. Fairbanks Company erected a building of special design for the production of automatic scales. This building was not used for the purpose for which it was intended, however, and it has just been leased to the Beckwith Box Toe Company, who are establishing a Canadian branch, the American plant being in Dover, N.H.

The Sherbrooke Machinery Company, who, a few years ago, started with a factory 60 x 100 feet, are now completing an addition which will give them a building 100 x 200 feet. The new addition is mill construction with large travelling crane running through the centre and galleries on the wings. This company has been continually working on its regular line, which is paper making machinery.

Electrical Section of the C.S.C.E. Meets

At a meeting of the Canadian Society of Civil Engineers—electrical section—on March 15, Mr. De Gaspe Beaubien, who presided, introduced Mr. Fraser S. Keith, the new secretary, to the members. Mr. Keith, in a brief speech, requested the co-operation of the members, as it was by this means that the society would make definite progress. The chief paper of the evening was by Mr. J. A. DeCew, on "Some Studies on the Methods of Recovering Antimony from its Ores by Volatilization Processes." Afterwards Major Stanley D. Parker, chief instructor of the engineers' training depot, St. Johns, P.Q., spoke on the co-operation of the engineer and infantryman in trench warfare. By means of a very large model of a trench, Major Parker described the materials and methods of construction and of defence. He also explained the reasons for the many changes which had taken place in the form of the trenches with the object of protecting the soldiers from the heavy shells.

Honors Conferred on Eminent Engineers

Sir John Kennedy, consulting engineer of the Montreal Harbour Commissioners, and one of the eight honorary members of the Canadian Society of Civil Engineers, has been further honoured by the granting by McGill University of the honorary degree of LL.D. The official reason for the awarding of the degree is because of his "eminence as a civil engineer, of the fidelity with which he has always upheld the highest ideals of the engineering profession, and of his long and distinguished services in developing the port of Montreal and the transportation routes of Canada, services which His Majesty has graciously recognized by conferring upon him the honor of Knighthood." The University has also awarded the degree to Mr. John J. Carty, of New York, in consideration of his "high standing as an engineer, for his work in connection with the development and successful operation of wireless telephony, and for his energetic support of pure scientific research as an aid to industry." Mr. Carty is chief engineer of the American Telegraph & Telephone Company.

Engineers Represented at Industrial Preparedness Conference

The Canadian Society of Civil Engineers was represented by the president, Mr. J. S. Dennis, at a conference held on March 15 in Ottawa, and called by Sir George Foster, to consider the question of industrial preparedness. The memorial prepared by Sir Charles Ross, and Messrs. W. J. Francis, R. A. Ross, C. H. McLeod, and H. R. Safford, was incorporated in the minutes of the conference, which was attended by those who will play an important part in the economic preparedness of Canada after the war. This is a subject in which Mr. Dennis takes a strong interest, and formed the main topic of his speech when elected president of the Society of Civil Engineers.

Brick Interests Acquired

Announcement is made by officials of the Metropolitan Paving Brick Company, of Canton, Ohio, of the purchase of the brick interests of the Bessemer Limestone Company of Youngstown, Ohio, thereby increasing the large capacity of the former company to the extent that it is now, without question, the largest paving brick company in the world. By the terms of the purchase, the Metropolitan Paving Brick Company has acquired the mammoth brick kilns of the Bessemer Company, which are located at Bessemer, Pa., including hundreds of acres of paving brick shale. The Metropolitan company takes charge of the additional factories as of March 1st, 1917. The general office of the company will continue at Canton, Ohio, the same as previously.

Contracts for Pumping Equipment

The Turbine Equipment Company, Limited, have received the following contracts for pumping equipment:—

From the town of Lindsay.—1 De Laval 2-stage pump, having a capacity of 1,250,000 Imperial gallons a day, for domestic requirements, and 1,750,000 Imperial gallons a day for fire requirements. A vertical high speed gasoline engine will be connected by clutch to one side of the pump, and the electric motor on the other.

From the town of Barrie.—1 De Laval single stage centrifugal pump, capacity 1,000,000 to 1,500,000 million Imperial gallons a day, to operate against 87 lbs. pressure and direct connected to 100 h.p. electric motor.

From International Nickle Company, Port Colborne, Ont.—1 De Laval 130 h.p. steam turbine-driven centrifugal Underwriter fire pump.

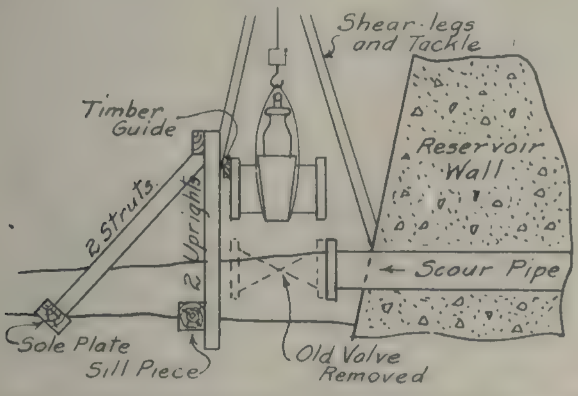
Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Reservoir Scour Valve Replaced Against Pressure

The renewal or repair of a scour valve in a reservoir wall must always involve considerable care. After these valves, generally ordinary screw-down stop-valves, are built in, they are often neglected or are not worked efficiently, with the result that grit accumulates and hardens in the working parts and the valve spindle refuses to turn.

This was found to be the case with the Katoomba storage reservoir. The wall, a curved one, 21 ft. high, had recently been raised a further 25 feet to increase the storage, and during this work it was necessary to keep the water level near its original height, so that it should not rise too quickly against the new concrete. Naturally, an attempt was made to open the scour valve, in this case a 12-inch stop-valve, but the spindle refused to move. Under repeated efforts it broke, and was found to be bent as if at some time it had been turned in the wrong direction. Another spindle was obtained, and inserted through the nut. This time when the key was applied the spindle was turned a few threads, when the cast-iron lug holding the nut snapped, and the whole valve became unworkable. This catastrophe was due to no unusual strain, but simply to the cementation of the valve face against the guides owing to long disuse.



Arrangement to permit insertion of scour valve against pressure.

A new valve was at once obtained with a flanged connection bored to suit the flanged end of scour pipe.

At this stage the question arose whether an iron plate or weighted wooden disc should not be lowered on the water side of wall to be drawn in against the water end of the scour pipe and so close the pipe, and shut the water off during the process of fixing the new valve. There was, however, the objection that soundings showed, or appeared to show, a considerable depth of silt over the pipe. It might be held that this silt would have been rapidly cleared from the end of the pipe with the first rush of water, but this seemed doubtful, and certainly a great deal of water would have been lost, a consideration which was not to be minimized.

There seemed, on the other hand, to be no adequate reason why the valve should not be fixed against the pressure, or, rather, in a manner to evade the pressure. The following method was adopted, and is described in the Sydney (N.S.W.) Government Report of the Department of Public Works by F. C. Kendall.

Over the site of the valve a shear-leg tackle was erected, and the new casting was slung directly over its intended position. In view of the great water force to be resisted, a vertical frame of timber was erected at a distance from the flange of the scour-pipe, about 2 inches in excess of the length of valve casting. This frame consisted of two vertical uprights 6 in. by 6 in. oregon, bottomed and fixed securely against a sill-piece which was well anchored into the banks of scour drain. The uprights were tied at the top by a heavy crosspiece of oregon. Strong struts were placed at the back or downstream side of the frame, and butted against a firm sole plate. The whole arrangement is shown on the accompanying sketch.

The bolts in the flange of the old valve nearest to the wall were then unscrewed and drawn back flush with the scour-pipe flange to be ready to insert in the new valve at the proper moment. A gang then quickly pulled away the old valve.

The water now rushed out under full bore with 26 feet of head. The new valve was then lowered by the tackle. It should be mentioned that it had a cross piece of smooth timber, bolted transversely to the flange at the outlet end. As the valve descended the water impinging upon it drove it hard against the framework, down the uprights of which the crosspiece of timber just alluded to slid down, acting as guide. The valve in the casting was open, so that the water-jet soon rushed almost wholly through the casting and the heavy pressure was at once relieved. After very little trouble the bolt holes in the valve flange were brought opposite the corresponding ones in the scour-pipe flange, when the bolts already in position were driven through and the flange packed and secured. After this the valve was closed and the operation completed, the water being once again under full control.

Increase in Munitions

In the course of a speech delivered on February 13, Dr. Addison, Minister of Munitions of War for Britain, said that, if they were to take the average weekly output of light field ammunition from July, 1915, to June, 1916, and compare it with the average for January last, the figures would come out 6½ for the former period and 22 for the latter. For medium guns, the figures would be 7½ and 76, and for heavy guns 22 and 365 respectively.

The Water Powers of Western Canada

Comprehensive Data on the Hydraulic Resources of Manitoba, Saskatchewan and Alberta Compiled by the Commission of Conservation—This Article Deals with the Winnipeg River Sources

The Dominion Government controls the water resources of the Prairie Provinces, and, during the past three or four years, has been particularly active in investigating them. The Water Power Branch of the Department of the Interior administers the water-powers which come under the jurisdiction of the Dominion Government, and has not confined itself to the regulation and supervision of proposed developments. In the territory under its jurisdiction it has sent out field parties to investigate many of the water-powers and to establish numerous gauging stations, where regular observations are taken. This branch has been in active operation since 1908, and, during the past three years, has covered most of the rivers in the southern portion of these provinces. Particular attention was paid to the Winnipeg River, in eastern Manitoba, and to the Bow River and adjacent basins on the Rocky Mountain slope. Reports on these two districts have been prepared, under the supervision of Mr. J. B. Challies, Superintendent of the Dominion Water Power Branch.

Southern Portion More Fully Investigated

The southern or more settled portion of the Prairie Provinces is fairly well covered by the work of these two branches of the Department of the Interior. As the northern portion had not been investigated by any other organization, the Commission of Conservation undertook exploratory surveys of the principal rivers in this region, the investigations covering the Athabaska, Peace, Slave, Nelson and other smaller rivers. The rivers were traversed, generally, by canoe, the descent of the falls or rapids being levelled, flow measurements taken, and other details connected with the feasibility of development noted.

For the rivers further north, information was obtained from the reports of explorations made by the Geological Survey, the data being compiled from reports and maps of this branch and from the explorers' notes, which were courteously placed at the disposal of the Commission. In this region, generally speaking, the information available respecting the different rapids and falls is confined to a statement of the vertical descent, but, in many cases, the geological formation and distances from head to foot of the rapids are also given, as this information may assist in deciding the feasibility of development.

The southern portion of the Prairie Provinces may be divided into three sections, having widely different water-power characteristics:

1. The portion in the vicinity of Lake Winnipeg, in the east.
2. The more level portion in the centre.
3. The mountain and foothill country in the west.

In the first, or eastern portion, the Winnipeg River is the main feature. This river, with its drainage area of 53,500 square miles, has a well-regulated flow and affords numerous water-powers of immense value. Two of the sites have already been developed and supply the city of Winnipeg with its electrical energy, while construction work on some of the other sites has either been commenced or is on the eve of starting. Numerous smaller streams in this eastern portion also afford splendid opportunities for water-power development, some of them being actually utilized on the Minnedosa and Shell rivers. This section also includes the Grand Rapids of the Saskatchewan River, where a head of 80 feet is available, affording an exceptionally good power site.

Middle Portion Unfavorable to Development

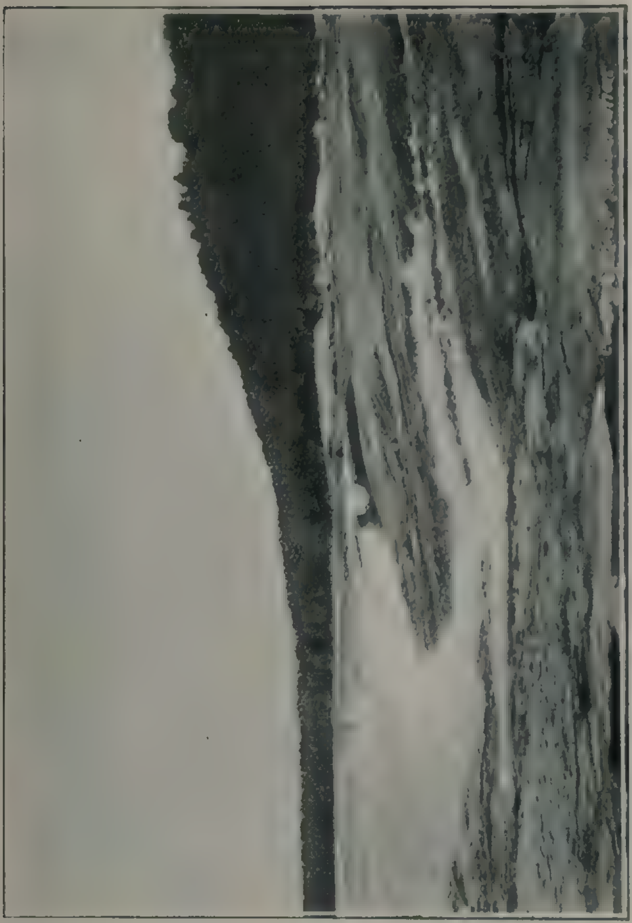
The second, or middle portion, is traversed by two main arteries, the North Saskatchewan and South Saskatchewan rivers. These, with their main tributaries, flow with an even, moderate current with no concentrated descents of importance. Although, strictly speaking, this portion is not entirely without water-powers, yet the possibilities of such are rather unfavorable. In almost every case the total head would have to be created and several proposed developments have already been abandoned on account of the high cost of development.

The third portion, of which the Bow River is typical, has many valuable water-powers. There are none of unusual size, those on the Bow River itself probably being the most important. The slopes of the streams, characteristic of a mountainous region, are generally very steep, and, while the flow of water is subject to fairly large variation, good opportunities for storage and artificial regulation are afforded.

With regard to special measures taken by the Dominion Government in connection with the administration of the water-powers in the southern portion of the Prairie Provinces, the setting aside of the eastern slope of the Rocky Mountains as a forest reserve, known as the Rocky Mountains Forest Reserve, may be mentioned first. This step was taken on the recommendation of the Commission of Conservation, and, as a result, an area of 17,900 square miles has been assured protection from such denudation as has already taken place in some of the older provinces. All the upper tributaries of the North Saskatchewan and South Saskatchewan rivers have their sources within this area, and the beneficial effect of conserving its forest cover is evident as far east as the Grand Rapid on the main Saskatchewan River. With a similar object in view, the Commission has recently recommended that steps be taken to segregate, as a forest reserve, the upper portion of the drainage area of the Winnipeg River.

Water Powers on the Winnipeg River

Winnipeg River is one of the most notable power rivers on the continent; it flows in a westerly direction, connecting the Lake of the Woods with Lake Winnipeg. The basin drained comprises an immense area of some 53,500 square miles. As is typical of Laurentian country, the area is dotted with innumerable muskegs and lakes, the latter varying in size from small ponds to the Lake of the Woods, with an area of 1,500 square miles. Since practically the entire basin is of Laurentian formation, containing areas of overlying soil of glacial origin, certain general characteristics apply to the drainage basin as a whole. The country is rough and hilly, with large areas of rock outcrop. This latter feature applies in the main throughout the Winnipeg River, and lends itself to a characteristic formation throughout the river channel, which is of exceptional value in the interests of power development. The larger proportion of the river bed in the Province of Manitoba consists of a series of deep, cup-like basins, forming small, lake-like expanses, with little or no current. The river flow finds its way from these basins by falls and rapids over the rock formation, which is always in evidence at the outlets, and which forms both the means of egress from and the controlling feature of the basin water



Winnipeg River—Little du Bonnet Fall

Winnipeg River—Grand du Bonnet Fall (Second Pitch)

Winnipeg River—Second McArthur Fall

Winnipeg River—Pine Fall

level. These falls form the natural power sites along the river.

Estimates of the daily flow of the Winnipeg River have been compiled by the Manitoba Hydrometric Survey, based on discharge measurements secured by them, together with results of measurements supplied by Col. Ruttan, D. A. Ross and the city of Winnipeg power engineers. These estimated discharges extend over a period of eight years. For this period, a maximum flow of 53,400 second-feet and a minimum flow of 11,700 second-feet have been recorded. The high water marks along the shore indicate that floods of 100,000 second-feet have occurred, but such freshets take place only at rare intervals.

The question of storage on the upper waters of the Winnipeg River is, at present, somewhat involved, inasmuch as the regulation of the Lake of the Woods is an international question, and is now before the International Joint Commission. As the lake has a tributary drainage area of 26,400 square miles and a surface area of 1,500 square miles, offering unexcelled storage facilities, it is of vital importance to the powers of the Winnipeg River that storage should be had on this lake. Partial regulation of the drainage tributary to Rainy Lake is now controlled on Rainy Lake by the dam of the Ontario and Minnesota Power Company at Fort Frances. By the establishment of storage reservoirs on the English River, the flow of the latter can be regulated; and, in conjunction with storage on the Lake of the Woods basin, a very complete regulation of the flow of the Winnipeg River in Manitoba can be attained.

Power Sites Developed

Point du Bois Fall is utilized by the city of Winnipeg to generate power for its municipal electric plant. The natural fall was from 33 feet to 28 feet, depending upon the stage of the river, and the dams, as now constructed, increased the fall to 48 feet and 44 feet at low and high water stages, respectively, while the normal head is 45 feet. There was, originally, a stretch of slack water, eight miles long and about 3,600 acres in area above Thirty-foot and below Lamprey Falls. It has been increased by the development works to 6,500 acres, and is of considerable advantage in the operation of the plant. The present installation consists of five units of 3,750 kw. and three units of 5,100 kw. capacity, making a total of 34,050 kw. Future extensions are planned which will accommodate eight additional units of 5,100 kw. each.

The Winnipeg Electric Railway Company's power-house is constructed on the Pinawa branch of the Winnipeg River. The development work involved much rock cutting and the construction of a diversion weir, which raises the water by about six feet at the head of the channel. The head utilized is 39 feet and the generating equipment consists of four units of 3,000 kw. and five units of 1,500 kw. each, giving a total capacity of 19,500 kw.; but a greater load than this has been carried on the plant.

Government Power Proposals

The cost estimates for the government power proposals on the Winnipeg River refer in all cases to the capital cost of installation, and are based on both an initial and final development. The initial development is designed to utilize at each site the present minimum flow of the river, i.e., 12,000 second-feet, or such portion of it as may be available at the particular site in question. The final development is designed to utilize, at each site, a regulated flow of 20,000 second-feet, or such portion of it as may be available at the site. After the diversion of sufficient water in the Pinawa channel to properly operate the plant of the Winnipeg Electric Railway Company under normal peak-load conditions, there would remain for use at Seven Sisters, in the main river, about 4,000 and 12,000 second-feet under unregulated and regulated conditions of the river, respectively. It is important to note that it is on this basis the available power at the Seven Sisters site is discussed.

To compare the power sites on a rational and equitable basis, all the layouts and designs have been standardized insofar as possible, giving full consideration to the varying heads and to the local physical conditions at each individual site. No allowance has been made in the estimate for transmission, the costs being in all cases the capital cost for power on the low tension switchboard in the power-house, and the power being considered as straight 24-hour service at 75 per cent. efficiency, based on the flow. This forms a very conservative basis. Transmission costs are omitted from the estimates, as it is impossible to foretell the use to which the power at the various sites may be applied when developed, and a straight comparison of the sites as they stand is desired.

In all cases the dams are designed in solid concrete, with ample discharging capacity to pass the severest floods to be anticipated. The power stations have been developed on single runner, vertical turbine installations, varied for the different heads and to meet local conditions.

Slave Fall Site.—The proposed development at Slave Fall concentrates a head of 26 feet, formed by the combination of Slave and Eight-foot falls. The dam runs along the crest of the fall, and, curving downstream, through an arc of about 90 degrees, connects with the power station on the right bank of the river. Provision has been made for the future installation of a lock on the left bank. The head-water elevations, as at present proposed, are 928 and 902 respectively. The initial installation, upon which the estimate is based, provides for eight 5,000-h.p. turbines, sufficient to provide for a flow of 12,000 second-feet at eight-tenths gate, with a spare machine for emergencies. On a 75 per cent. efficiency, 24-hour basis, 26,600 h.p. will be available at a capital cost of $87.50 per horse-power at the low tension switchboard. The final installation provides thirteen 5,000-h.p. turbines, sufficient for a flow of 20,000 second-feet, at eight-tenths gate, with a spare machine for emergencies. On a 75 per cent. efficiency, 24-hour basis, 44,400 h.p. will be available, at a cost of $77.40 per horse-power at the switchboard.

Upper Pinawa Site.—This site is about three miles above the Winnipeg Electric Railway Company's plant on the Pinawa channel. It utilizes a hitherto inconsidered source of power in what may be termed the headrace of this company's plant. The head to be developed here will normally average 18 feet, with the head and tail-waters at elevations 899.5 and 881.5 respectively. A flow of 8,000 second-feet will produce 12,300 continuous twenty-four hour power at 75 per cent. efficiency. To develop this power an installation of four 4,500 h.p. turbine units has been assumed, the capital cost of the installation being $104.05 per horse power on the low tension switchboard on a basis of twenty-four-hour power.

Upper Seven Sisters Site.—The Upper Seven Sisters site is situated about four miles above the lower. The tail-water, under normal conditions in the river, will be at elevation 870, i.e., the proposed head-water elevation of the plant below. The head-water level has been placed at an elevation of 899, giving a normal head of 29 feet. Since, to properly operate the existing development of the Winnipeg Electric Railway Company, an average flow of 8,000 cubic feet per second is assumed down the Pinawa channel, it will not be feasible to develop the Seven Sisters site until the flow has been regulated to a minimum of 20,000 cubic feet per second. Assuming the use of 12,000 second-feet, the power station provides for a complete installation of eight 6,000-h.p. units, providing a spare unit for emergencies. The estimated output on the low tension switchboard at 75 per cent. efficiency is 29,600 horse-power, 24-hour service. The estimated capital cost per horse-power would be $92.

Lower Seven Sisters Site.—The Lower Seven Sisters site is situated about 19 miles above the McArthur site, and contemplates the development of the lower five descents of the Seven Sisters Fall. The tail-water elevation has been assumed at 833, six feet being allowed for the hydraulic gradient in the river between the site and the regulated lac du Bonnet. The head-water is placed at elevation 870, the river banks permitting this raising of the water without necessitating embankments. A head of 37 feet will be available under normal conditions. The power station provides for a complete installation of six 10,000-h.p. turbine units, sufficient to utilize a flow of 12,000 cubic feet per second. On a 24-hour and 75 per cent. efficiency basis 37,900 horse-power will be available, at an estimated capital cost of $90 per horsepower, on the switchboard.

McArthur Site.—At the lower of the two McArthur Falls, a head of 18 feet awaits development. The river is here divided into two channels by a large island. The general project consists of a solid concrete spillway, along the crest of the fall on the right or main channel, and a long spillway and embankment, including sluiceway provision, running diagonally across the island and connecting with the power station spanning the left channel. Provision is made on the island for the future construction of a lock. The headwater elevation is at present fixed at 827, i.e., about the highest recorded water level of lac du Bonnet. The tail-water is proposed at 809, giving a head of 18 feet. The initial installation provides for eleven 2,500-h.p. turbines, sufficient to provide for 12,000 second-feet at eight-tenths gate, with a spare machine for emergency. On a 75 per cent. efficiency, 24-hour basis, 18,400 h.p. will be available, at a capital cost of $110.40 per horse-power at the switchboard. The final installation provides for seventeen 2,500-h.p. units on a basis of a 20,000 second-feet flow, and 75 per cent. efficiency, 24-hour power, i.e., of 30,700 h.p. The cost per horse-power on the switchboard is $89.25. This site can be given a much more favorable aspect, when the local storage available in Lac du Bonnet (whose 32 square miles form the head-waters) is taken into consideration.

Du Bonnet Site.—The proposed scheme of development at the Du Bonnet Falls will ultimately concentrate there a head of 56 feet, made up of the Grand and Little du Bonnet falls and Whitemud fall. The latter will be removed by blasting out the rock-dam over which the present fall flows. The dam, consisting of embankment, spillway and sluiceway sections, leaves the left bank and crosses the river on the brink of the Little du Bonnet fall, connecting with the power station which parallels the right shore line below the patch. Ice sluices and embankment connect the power station with the high land on the right bank. Provision is made for future lockage facilities on this bank. The head-water elevation has been fixed at 808, with the tail-water at 762 previous to the blasting out of the Whitemud fall, and 752 subsequent thereto. This secures a head of 46 feet for the preliminary, and 56 feet for the final installation. The initial installation is figured on seven 10,000-h.p. turbine units, utilizing 12,000 second-feet at eight-tenths gate and 46-ft. head. This, on the foregoing basis, will render available 47,100 horse-power, at a capital cost of $77.20 per horse-power, at the low tension switchboard. An intermediate installation, comprising 12 units, providing capacity for 20,000 second-feet at 46-ft. head, and producing 78,700 horse-power, has also been estimated. The cost of the power at the switchboard for this intermediate installation is $66.70 per horse-power. The final installation consists of fourteen 10,000-h.p. units for the development of 20,000 second-feet at 56-ft. head, the extra ten feet being secured by the removal of the Whitemud fall. On the above basis, 95,500 continuous horse-power will be available at a cost of $68.60 per horse-power on the switchboard.

Pine Fall Site.—The Pine fall development will concentrate the natural descent of the Pine and Silver falls, giving a head of 37 feet. The dam runs diagonally across the river from the right bank and joins directly to the power station, which forms a continuation of the dam. The power station is connected with the high ground on the left bank, by sluices and embankment. Provision is made for lockage facilities on this bank. The head-water and tail-water elevations have been placed at 750 and 713 respectively. As the tail-water is practically Lake Winnipeg level, it will vary slightly from year to year with the level of the lake. The initial installation is placed at six 10,000 h.p. turbine units using 12,000 second-feet at 37 feet head. On the foregoing basis, this will render available 37,900 h.p. at a capital cost of $80.70 at the low tension switchboard. The final installation consists of ten 10,000 h.p. units for the development of 20,000 second-feet, rendering available 63,100 h.p. at a cost of $69.80 per horse power.

Summary of the Power Possibilities of the Winnipeg River

The developed and undeveloped powers of the Winnipeg River, under regulated and under unregulated conditions, are tabulated in the table herewith. The undeveloped power is considered on a 75 per cent. efficiency, 24-hour basis, and the capital cost per horse-power is given in terms of this power, estimated to the switchboard in the power-house.

TABLE OF DEVELOPED AND UNDEVELOPED POWERS ON THE WINNIPEG RIVER IN MANITOBA

Plant or site	Head-water, elevation	Tail-water, elevation	Head	Turbine capacity at full gate at Govt. proposals		H.P. at 75% efficiency on a 24 hr. basis		H.P. developed	Capital cost per h.p. on switchboard		Remarks
				12,000 sec.-ft.	20,000 sec.-ft.	12,000 sec.-ft.	20,000 sec.-ft.		12,000 sec.-ft.	20,000 sec.-ft.	
									$ cts.	$ cts.	
Winnipeg municipal plant	975.7	930.7	45			46,100	76,800	25,000			47,000 h.p. installed.
Slave Falls site	928	902	26	40,000	65,000	26,600	44,400		37.50	77 40	
Winnipeg Electric Railway Co. plant	879.4	840.4	39					28,200			On Pinawa channel. 34,000 h.p. installed.
Upper Pinawa	899.5	881.5	18	18,000	18,000	12,300	12,300		104.05	104.05	On Pinawa channel.
Upper Seven Sisters site	899	870	29		48,000	9,900	29,600			92.00	Less discharge down Pinawa channel.
Lower Seven Sisters site	870	833	37		60,000	12,600	37,900			90.00	Less discharge down Pinawa channel.
McArthur site	827	809	18	27,500	42,500	18,400	30,700		110.40	89.25	
Du Bonnet site	808	762	46	70,000	120,000	47,100	78,700		77.20	66.70	Preliminary head.
		752	56		140,000	57,300	95,500			68.60	Final head.
Pine site	750	713	37	60,000	100,000	37,900	63,100		80.70	69.80	

Total power with unregulated river (12,000 second-feet min. flow) is 249,300 horse-power.
Total power with regulated river (20,000 second-feet reg. flow) is 418,500 horse-power.
Total power developed to date, 53,200 horse-power.

Cement Situation Optimistic

Statements made at the annual meeting of the Canada Cement Company held in Montreal were of an optimistic character. Senator Edwards, president, stated that the board were of opinion that dividends could be maintained out of cement earnings and would not depend on profits from war orders. In spite of the fact that there was no great amount of building in the past year, the company had been able, from their earnings from the sale of cement, to pay bond interest as well as dividends on both the common and preferred stock. He felt that this year would hardly be worse as far as building was concerned, and he believed the company should show an even larger surplus. Mr. F. P. Jones, general manager, spoke of the success of the company's educational campaign, pointing out that while the per capita use of cement was ⅝ of a barrel when the company started in business, it had now been increased to 1¼ barrels per head, and that over 2,300 customers were on the company's books.

Concrete for Ships

An English newspaper has suggested a novel use for ferro-concrete. This is for building ferro-cement vessels to meet the submarine menace. The main advantage claimed for ships so constructed over steel ships is that they can be turned out very much quicker —"faster than the Germans by any imaginable development of their barbarous methods can ever sink them." In addition an authority on the use of ferro-concrete asserts that ships can be built of reinforced cement—cement is proposed instead of concrete as being stronger and more buoyant—much more cheaply than by the present method, and their life would be longer on account of the non-exposure to the elements of the steel framework, which, of course, would be embedded in the cement.

To this suggestion a sailor wittily replied: "All very well talking about ferro-concrete ships; what you really want is a ferro-concrete crew."

It may be added that a few vessels, principally barges, have been constructed in Canada, notably for the Welland Canal. "The difficulty with concrete for shipbuilding," said Mr. J. A. Jamieson, of Montreal, "is the liability to crack when the vessels are damaged, and there is also the difficulty of repairing the concrete. Concrete is a splendid material but it has its limitations, and so far it has not been proved the best thing for shipbuilding."

New Books

Reinforced Concrete Design Tables—by M. Edgar Thomas and Charles E. Nichols; McGraw-Hill Book Co., Inc., 239 West 39th Street, New York, publishers; $3.00 net. A handbook for engineers and architects for use in designing reinforced concrete structures. The tables, as presented, cover a wide range of stresses and include those used by designers in general. They may readily be applied to the design of any reinforced concrete structure. Even to the designer already possessed of a complete set of curves or tables which answer his needs, this volume offers an independent check which should be very valuable in securing accurate results. Limp cover; 210 pages; size 4 in. by 7 in.

At a meeting of the Grain Growers' Grain Company, held in Winnipeg recently, it was announced that several elevators would be built by the company this year in Manitoba and Saskatchewan.

Mainly Constructional

East and West—From Coast to Coast

The Toronto Board of Education has approved plans for a 12-roomed school on Glenholme Avenue, to relieve the district of Earlscourt School.

The roadway on Water Street, Galt, Ont., is reported to be in very poor condition, and it has been proposed that a permanent pavement should be laid immediately.

Considerable road work is planned this year by Delta municipality, B.C., a sum of $24,000 having been appropriated for that purpose. Rock for the work is being shipped in.

A by-law has been passed in Sudbury, Ont., appropriating $17,226 for sanitary sewers, $8,133 for concrete walks, $10,288 for Warrenite paving, and $64,390 for bithulithic pavements.

The Hamilton, Ont., Board of Control have passed a resolution requesting the Toronto-Hamilton Highway Commission to defer the completion of the highway into Hamilton until next year, because of the war.

It is announced that the contract for the building of extensive additions to the munitions plant of the Peters Cartridge Company, at King's Mills, Ohio, has been awarded to Wells & Gray, Ltd., Toronto, their figures totalling $175,000. These contractors carried out construction work for the same corporation in 1915.

Penmans, Limited, of Paris, Ont., have let the contract for a fine Y.W.C.A. building, to be erected immediately north of the Methodist Church on Broadway. The building, which will be a handsome brick structure, will be principally for the use of the employees at Penmans, and will be equipped with every modern convenience.

The proposed Windsor to Montreal highway provided for in the bill introduced at the Ontario Legislature will pass through the most densely populated sections of Ontario, serving 1,262,000 persons, or 52 per cent. of the population. The areas served will represent in assessment $1,134,000,000, or 50 per cent. of the total provincial assessment.

Winter, Williamson & Little, of Windsor, Ont., have acquired property on Goyeau Avenue, on which they propose to erect a big apartment house. The property includes three dwellings facing on Goyeau Avenue, including the old Horton home. These will be moved or torn down and a three-storey building, with 24 apartments, erected.

At a recent meeting of the Winnipeg School Board there was some discussion regarding the need for increased school accommodation in certain sections of the city. It was decided that a special meeting of the School Management Committee be called and that all the members of the board be invited to be present and discuss the matter with them.

A new $75,000 hospital to take care of cases of measles and whooping cough was recommended by Dr. C. J. O. Hastings, medical health officer of Toronto, before the Board of Health. The board approved the idea, and decided to hold a conference with the Property Committee as to the advisability of appropriating part of the old jail grounds for a site.

The Bonner-Worth Company, a worsted spinning mill of Peterboro, Ont., have machinery on order for the installation of the "French spun" process, and expect its delivery this summer, when construction of a new plant will be commenced. The plans call for a three-storey building some 150 feet in length, and will mean the employment of 90 additional hands.

No estimates of construction cost are submitted in connection with the Provincial Highways Bill in the Ontario

Legislature. The Premier stated that with the labor market in its present state and with conditions upset by the war and uncertain after the war, engineers had assured him it was impossible to give estimates which could be reasonably accurate.

A deputation from Stouffville, Ont., will wait upon the York highway commissioners to protest against the contemplated improvements to the roadway between Langstaff and the Fifth Concession of Markham Township, and between Markham village and Locust Hill, being undertaken until Stouffville is linked up with the present system on the Sixth Concession.

The east section of the old wooden bridge over the Capilano River, B.C., on Keith Road, recently collapsed. The bridge has been in an unsafe condition for some months and has been closed to traffic on that account. Its western end is fairly intact, and may be used in the contemplated scheme for a pedestrian bridge over the river at this point. In any case, a pedestrian bridge to replace the old traffic bridge is possible, as tentative plans for a suspension bridge have been discussed.

Works Commissioner Harris, of Toronto, has reported the costs of building permanent and temporary lines on Bloor Street, from Quebec Avenue west to Jane Street. They are as follows: Double track, temporary, Quebec Avenue to Runnymede Road, $40,776; double track, permanent, Quebec Avenue to Runnymede Road, $89,660; single track, temporary, Quebec Avenue to Jane Street, $66,319; single track, permanent, Quebec Avenue to Jane Street, $118,695; double track, temporary, Quebec Avenue to Jane Street, $86,361; double track, permanent, Quebec Avenue to Jane Street, $176,103.

The new plant for the Goodyear Tire and Rubber Company, which is being constructed at New Toronto, will be completed about May 1. The building is 560 feet long by 80 feet wide, four storeys and basement. One and one-half million dollars will be spent on it. In connection with the factory there is one of the finest chimney stacks in Canada. It is 14 feet in diameter and 250 feet high. Approximately 600 men will be employed when the plant is opened, but the factory is large enough to employ 1,500. The Goodyear Company own 28 acres at New Toronto, and propose to build six factories of similar size, as their business demands.

The concrete superstructural work on the government piers at Victoria, B.C., has now been completed. These concrete walls are built up on foundations prepared by the sinking of 52 caissons. The contractors, Grant, Smith & McDonnell, Ltd., are now engaged in filling in the space inside the pier walls, and it is expected that this section of the work will be completed within a couple of months. Most of the material for back-filling is being supplied by the big suction dredge now working in West Bay, from which it is transported by means of a submerged pipe-line under the entrance to the Inner Harbor and then overland to Ogden Point.

The new Suburban Planning Act, introduced in the Ontario Legislature by Hon. W. D. McPherson, grants control of suburban areas to the cities, towns, and villages of the province. This bill covers all urban municipalities. It gives the local council power to appoint a planning commission, and this commission may set out a suburban plan governing future streets, parks, etc. Then when the land is subdivided its layout must conform to that plan. Where there is a dispute the Ontario Railway and Municipal Board will adjudicate. The bill creates a suburban area of five miles around each city and three miles around towns and villages, within which the urban municipality may exercise a measure of control.

Two salmon canneries, costing approximately $100,000 each, will be built this spring on Vancouver Island by the Lummi Bay Packing Company, Ltd. Construction will begin at once on a two-line plant at Nitinat, on the west coast of Vancouver Island, twenty miles east of Barclay Sound. The main building will be of sufficient size to permit of the installation of several other lines should it prove necssary. It will have a seasonal capacity of from 75,000 to 100,000 cases. In the immediate future a similar cannery will be built in the same vicinity. Later developments will include the construction of a cold storage plant and five tenders and seine boats.

The city of Vancouver installed some years ago a considerable quantity of concrete sewer pipe, and has now between $80,000 and $100,000 worth in the ground. Recently some of these sewers have had to be renewed, the manufacturers supplying new pipe which they declared to be of an improved quality. City Engineer Fellowes, however, consulted Messrs. Robert W. Hunt & Co., inspecting and testing engineers, of Chicago, and has received a report from them regarding the concrete pipe. This report deals with three samples, two of the class of manufacture originally installed and one of the new pipe. Of the former one of the samples had been in use and the other had not. A test was carried out on the unused pipe, which failed to resist water percolation at ten pounds pressure, applied internally, and when twenty pounds was reached it cracked. It was impossible to apply the same test to the pipe that had been in use owing to irregularities at the end, which prevented it being sealed, but the engineers consider their verdict on the other sample applicable to this case. The sample of the newer class of pipe also failed to obtain the endorsation of the testing firm. They found that it did not resist percolation, and that the interior surface was not sufficiently smooth.

Personals

Mr. W. F. Tye, C.E., will be unable to visit Hamilton, Ont., to report upon a common entrance scheme for all railways before next June. He is at present engaged in Vancouver.

Mr. William Walker has been appointed acting division engineer, eastern lines of the Grand Trunk Railway, in succession to Mr. F. L. C. Bond, who has gone overseas with a railway construction battalion.

Mr. J. S. Dennis, president of the Canadian Society of Civil Engineers, has been authorized by the council to represent the society at the third annual conference of the Committee on Engineering Co-operation, to be held at Chicago on March 29 and 30. Prof. S. J. Newell of the University of Illinois is the president. The object of the conference is to prepare plans for co-operation on matters of general interest to the engineering profession.

Obituary

Mr. George Henry Frost, one of the oldest engineering graduates of McGill University, Montreal, passed away recently at Plainfield, N.J. Mr. Frost took his C. E. degree at McGill in 1860, and for some years practised the profession of land surveying at Smith's Falls, Ont., subsequently becoming an engineer on the Chicago and Northwest Railway and on the Grand Rapids and Indiana Railway, with headquarters at Chicago. Later he took up journalistic work, and in 1874 founded the Engineering News. Some years ago he retired from active work, and took up his residence at Plainfield, N.J.

Trade Publication

The Portland Cement Association has issued booklets entitled "Integral Curb for Concrete Pavement" and "Why Build Fireproof." These will be distributed to those interested on request.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Bridgeburg, Ont.
Town plans to purchase an electric pump for pump house. R. A. Lans, town clerk.

Dereham Township, Ont.
Tenders will be received by the township clerk, Alex. Bell, Dereham Centre, until April 9 for the construction of Rutherford and Deer Creek drains for the Township Council.

Haldimand County, Ont.
The County Council will do 1½ miles of metalling, at a cost of $7,000, and expend $9,500 on repairs. Superintendent of roads, D. W. McBurney, Hagersville.

Hull, Que.
The construction of concrete pavement on Aylmer, from Bridge St. to Front, is being considered by the City Council. Engineer, J. A. Laforest.

The City Council plan to lay pavement, likely concrete, on Brewery Street, from Aylmer Road to Gatineau Road, and on Bridge Street, from Wellington to Phillemore. Engineer, J. Laforest.

London, Ont.
The City Council contemplate sewer extension on Nightingale Avenue. Engineer, H. A. Brazier, will report on cost.

Metcalfe Township, Ont.
Tenders will be received by the clerk, Harry Thompson, R.R. No. 2, Kerwood, until April 2 for the construction of the Murphy drain. Concrete or good tile specified.

Ottawa, Ont.
Tenders are being received by the engineer, Alex. Stuart, until March 31 for supplies required by the Ottawa Improvement Commission, 110 Wellington St., costing $97,000.

Quebec, Province of.
Tenders are being received by the secretary, G. H. Burroughs, Parliament Buildings, Quebec, until April 3 for the construction of pavement through Ste. Foy, from St. Augustin to Quebec City. Plans and specifications with the secretary.

Regina, Sask.
The City Council have had plans prepared for a $10,000 pump house for Boggy Creek. J. R. Ellis, 2852 Rae St., is architect. Clerk, George Beach.

Rooke Township, Ont.
Tenders will be received by the engineers, G. A. Gililland and Hugh Kennedy, care of the clerk, W. J. Weed, Alvinston, until April 7 for repairs of the Thompson and Carpenter drain for the Township Council.

St. Catharines, Ont.
Tenders close with the Board of Works April 12 for the construction of 485 lineal feet of 30-inch sewer and 525 lineal feet of 24-inch sewer. City engineer, W. P. Near.

St. Thomas, Ont.
The City Council are considering the construction of cement walks. Engineer, Mr. Ferguson.

Tenders will be called about June 1 for the construction of a macadam pavement on Wellington for the City Council. Engineer, Mr. Ferguson.

Toronto, Ont.
Works Commissioner R. C. Harris has included the following in his estimates: Additional pump and motor at Riverdale pumping station, $25,000; high pressure fire system extension, $600,000; extension of distribution system east of the Don River, $375,000; two 36-in. water mains from pumping station to Front St., $95,000.

Vancouver, B.C.
City plans improving sewer emptying into English Bay. About $20,000. F. Harris, waterworks commissioner.

Walkerville, Ont.
Plans are being prepared for a concrete and asphalt block pavement on Walker Road for the City Council.

Plans are being prepared for concrete sidewalks on Lincoln Road and Iroquois Street for the City Council.

Waterloo, Ont.
The construction of a storm sewer, to cost $3,000, is being considered by the Town Council. Work will be done by day labor, and Engineer Charles Moogh will purchase 24-in. and 30-in. concrete pipe.

The town engineer, Charles Moogh, will purchase 6 and 9-in. tile for the contemplated sewer extension, to cost $2,500.

Winnipeg, Man.
Time for receiving tenders for approximately 12,000 feet of 48-in. and 1,300 feet of 60-in. cast iron pipes, specials, and gate valves for the Greater Winnipeg Water District, 501 Tribune Building, has been extended, and tenders will be received by the chairman, R. D. Waugh, until noon, April 16. Specifications and form of tender at the office of the District.

CONTRACTS AWARDED.

Hull, Que.
The Ottawa Construction Company, Central Chambers, Ottawa, has been awarded the general contract for the construction of pavement on Laurier Avenue for the City Council, at a cost of $100,000. Engineer, J. Laforest.

Lindsay, Ont.
The Turbine Equipment Company, Ltd., C.P.R. Building, Toronto, have been awarded the contract for supplying a De Laval turbine pump to the Water Commission. Town Council.

St. Hyacinthe, Que.
The Turbine Equipment Company, Ltd., C.P.R. Building, Toronto, have been awarded the contract for the supplying of a De Laval turbine pump to the Waterworks Commission, City Council, in connection with filter system.

West Hawkesbury Township, Ont.
The general contract for the construction of a macadam road on Front Road, between l'Original and Hawkesbury, has been awarded to McDonald & Dibblie, 43 St. Sacrament Street, Montreal. The contract for the construction of four bridges on the road system has been awarded to the Ontario Bridge Company, Toronto, for $42,600, $16,400, $1,560, and $917.

Railroads, Bridges and Wharves

Banff, Alta.
The Cascade Scenic Railway plan to construct a railway up mountain near here. Work probably to start this year. Engineer, Harold Johnson.

Charing Cross, Ont.
The Michigan Central Railway intend to rebuild their railway station, at a cost of $3,000. Architect, H. A. Hornung, Jackson, Mich.

Peterboro, Ont.
Council plan to extend Peterboro Radial Railway. W. G. Ferguson 289 George St., local manager.

Saskatoon, Sask.
The City Council has authorized the expenditure of $19,640 on street railway and equipment. Superintendent, G. H. Archibald.

Springfield, N.S.
The Davison Lumber Company, Bridgewater, are considering the construction of twelve miles of railway.

Toronto, Ont.
City plans subway on Duplex Avenue, under Belt Line Railway. About $183,800. R. C. Harris, works commissioner.

Works Commissioner R. C. Harris has included in his estimates $149,370 for reconstruction of bridge on South Glen Road, and $63,200 for bridge on Spadina Road.

Walkerville, Ont.
The Essex Terminal Railway will make surveys for an electric railway from Ojibway to Amherstburg. Engineer, Owen McKay.

CONTRACTS AWARDED.

East Angus, Que.
The Phoenix Bridge and Iron Works, Ltd., 83 Colborne St., Montreal, have been awarded the contract for steel work for the $45,000 steel bridge across St. Francis River for the Municipalities of East Angus and Westbury.

McGillivray Township, Ont.
Frank Nichol, Parkhill, has been awarded the general contract for the erection of a bridge for the Township Council. Engineer, Charles Talbot, County Building, London.

Middleton Township, Ont.
A. L. Oatman, R.R. Tillsonburg, has been awarded the contract for abutments at $4,993, and the Sarnia Bridge Com-

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Alphabetical Index of Advertisers
Page 16

Vol. 31 April 4, 1917 No. 14

Principal Contents

Page
Editorial ... 295
Good Roads of Nova Scotia ... 296
Road Development in Quebec ... 296
Architecture in Bridge Building ... 297
By R. O. Wynne-Roberts
Good Roads and Motor Touring ... 299
By W. G. Robertson
Better Highways in Ontario ... 301
The Transportation of Materials ... 302
By Geo. Hogarth
Dust Preventives and Bituminous Binders ... 305
By G. C. Parker
The Design and Construction of Culverts ... 307
By Arthur Sedgwick
Important Details in Oiling and Tarring ... 308
By W. Huber
Maintaining Earth and Clay Roads ... 311
By A. A. Smith
Road Foundations and Drains ... 313
By R. C. Muir
Increasing the Safety of Our Highways ... 316
By W. H. Losee
Repairing Gravel and Stone Roads ... 318
By R. M. Smith
Fourth Canadian and International Good Roads Cangress ... 320
Personal Mention ... 322
Mainly Constructional ... 323

Good Roads Mean Prosperity

OUR present issue is given over almost entirely to discussions of roadway problems, because we believe the betterment and maintenance of our country roads is one of the most urgent of public works that can be undertaken by Canadian governments. Good country roads were formerly looked upon as a luxury, but not so to-day. They are now generally recognized as the only true basis upon which we can hope to build up a prosperous commercial activity throughout our country districts. And upon this activity is almost entirely dependent the prosperity of our cities and towns. In a word, the rural roads of Canada, more than any other single factor, will determine our future success or failure in taking a prominent place in the competitive commerce of this continent.

* * *

This being so, it is impossible to overestimate the value of the work being done by the Ontario Department of Public Highways in holding an annual conference on road construction for country road superintendents and engineers. The third of these conferences was held in Toronto last week, and many of the excellent papers and discussions are reproduced in this issue. Other provinces are doing most excellent educative as well as practical work along various, though somewhat different, lines. Equal importance must also be attached to the work of the Dominion Good Roads Association, which meets in Ottawa next week. Such forces as these associations represent are bound to effect very considerable results, not the least of which is the education of the average rural resident to bring him to a realization of the need of good roads and of their actual and practical possibilities.

And this last viewpoint probably brings one as nearly as one can get in a few words to the actual cause of such abominable roads as we have in various sections of Canada at the present time. (1) The country people have never known what really good roads are like, and so, by comparison, are generally satisfied. (2) They are not scientifically skilful in making and maintaining roads (especially the latter). For this reason the establishment of country road systems which takes the making and maintenance of roads out of the hands of men unskilled in this work and places it in charge of specialists is a big step forward. There is little doubt that this system should spread to all parts of the Dominion and become applicable to all the roads, within a comparatively short period.

* * *

Canada as a young nation in the making has, perhaps, made the mistake which is all too common with individual commercial enterprises—building only for the immediate future. There is little defence for such a course in a country so rich in natural resources of every sort as we are. There is no uncertainty about our future, in fact. It is merely a matter of time. Do we want to take our place among the big nations tomorrow, or shall we wait—fifty or a hundred years? On the answer might well depend our good roads policy of the immediate future. If we decide that we are now a grown-up nation—which most of us believe—then we must build roads to carry on the business we intend to do—good roads and permanent roads. These will cost more to-day, but less in the end. To this end the educative work being done by the various Canadian road organizations is of the greatest value.

Good Roads of Nova Scotia

Sparsity of population retards permanent development—Careful attention to maintenance—Educating the people

THE rural population of Nova Scotia gives about 17 head per mile of highway, for an average of the entire province. In some counties the average per mile is much below the general average for the province. It is therefore seen that much in the way of permanent roads cannot be attained without incurring expenditures unduly large for the population benefited. With the sparse population of the province, it is evident that the type of road to be dealt with, covering by far the largest percentage of the total mileage is the earth road. An earth road, when maintained in good condition with proper side drains, culverts and ditches, forms a pleasing kind of road, and its greatest fault, perhaps, is that it is more or less muddy. Taking traffic conditions also, as they exist in the province at the present time, there are not many districts in which an expenditure greater than that involved in an earth road is warranted by the traffic.

Water-bound Macadam Meets Requirements

There is no doubt that in some of the populous villages of the province the traffic requires a surface road of some kind. It is not thought, however, in any rural section of the province at the present time, that traffic demands a better class of highway than that of water-bound macadam.

In building permanent roadways, the most important features are the location, drainage and preparation of the subgrade. Since all steps in making good earth roads are essential to a permanent construction, it will be seen that nothing is lost in their building and that almost any earth road can be afterwards improved by putting over it some sort of hard surface to carry the traffic with more ease and safety. By constructing, therefore, a good quality of earth road, the province of Nova Scotia is making adequate preparation for a permanent highway system when conditions are such as to justify it.

The annual cost of maintenance of a good earth road will vary from $10 to $50 per mile, depending largely on the nature of the earth composing the prism of the roadbed. The total money available at the present time, both from funds supplied from provincial revenue and also under the Highway Act by way of statute labor, estimated at $12.50 a mile, would not suffice for more than the maintenance of the roads. Only a small proportion of the highways of the province are properly paved, ditched and drained. If, in addition to the maintenance of the roads, highway construction is also to be undertaken, it is more than evident that the provisions are insufficient.

Road Work Required at Frequent Intervals

The maintenance of an earth road in good condition requires constant attention and it is impossible to do all the work at one time in each season. On the contrary, it is necessary that a little work be done at frequent intervals throughout the year. It is in this particular that the Roads Office of the Province of Nova Scotia has made an endeavor to educate the inspectors in the different parts of the province as to the necessity of caring for the roads in the manner outlined.

The ideal method of caring for the highways would be to have the work done by somebody whose interest is centred in that work. The best results cannot be accomplished until the full work of road making in each county is conducted by a few gangs of men under an experienced foreman, who work for the entire season and will earn their living by building roads. It is not right to expect the construction and maintenance of roads to be attended to as an auxiliary to farming or any other means of livelihood.

The Roads Department has a set of road models which show the details of construction of each type of road at present being built in the province under the Roads Department. During the provincial exhibition, held last September, a roads exhibit was prepared, of which these models formed a part, together with photographs and drawings of structures built in the province. This exhibit, in charge of the engineer of the department, was intended as an element in an educational campaign and attracted so much attention and caused so much favorable comment that it is intended in future to utilize the exhibition as far as possible as an educator in road matters for all interested. In addition to this particular form of publicity the department undertakes instructional supervision in the field of construction and has arranged illustrated talks on roads so that the people of the various counties may be impressed with the value of good highways.

Road Expenditures

The expenditure during the past fiscal year has been in accordance with the following table:

Road appropriation for maintenance	$216,722.97
Chapter 18, Acts 1913 "Betterment of Highways"	36,536.27
Chapter 19, Acts 1913, "Motor Vehicle Act Road Improvement Fund"	17,768.87
Chapter 26, Acts 1912, an "Act respecting the construction, of permanent materials, of smaller bridges and culverts in public highways"	147,902.04
Larger Bridge Construction	113,564.70
Total	$532,494.85

Road Development in Quebec

Past year's work—Government assists building of trunk highways and loans funds—This year's expenditure $1,000,000

By B. Michaud*

DURING the construction season of 1916 there have been built in different municipalities of the Province of Quebec, including provincial roads, 106 miles of macadam and 74 miles of gravelled roads. The total mileage of improved roads built since 1911, under the control of this department, is 1,279 miles of macadam and 658 miles of gravelled roads.

This province now has five trunk roads, aggregating above 300 miles, linking together Rouse's Point, Montreal, and Quebec, Levis and Jackman, Sherbrooke and Derby Line, Montreal and St. Johns's, via Chambly. Another trunk road connecting Three Rivers, Shawinigan Falls, and Grand' Mere will be built, with the aid of these cities and of certain companies, the government contributing one-half of the cost.

The preliminary work for this latter line will commence as soon as the season is favorable. This road is not, properly speaking, a provincial road, identical with the five roads above mentioned, but it it an instance showing what an incentive has been the construction of provincial roads to the construction of continuous stretches.

---

*Deputy Minister of Roads, Quebec.

Smallman sideroad, Dundee, Quebec, macadamized in 1915.

The Quebec Government offers every opportunity to municipalities to unite together and build such continuous stretches of roads with money supplied to them by the government at 3 per cent. Some districts are already organized with a view to working along these lines, and it is reasonably certain that within a few years several trunk roads will be entirely built by the municipalities themselves, in addition to the provincial roads built by the government.

To the $15,000,000 voted since 1912, and which were allotted to the municipalities, provided they pay an interest at 2 per cent. during 41 years, five other millions have been voted during the last session, and will be allotted at 3 per cent. In both cases the sinking fund is paid by the government.

The expenditure for road construction during the coming season will probably be a little over $1,000,000, besides the annual appropriation of $250,000 for construction and maintenance, which has been raised this year to $300,000.

The main feature of the Quebec road policy this year is the putting in force of a law passed during the last session regarding the maintenance of macadamized or gravelled roads. As to the provincial roads, they will be maintained directly by the government, and a contribution of 50 per cent. will be asked from the municipalities interested. The roads built by the municipalities must also be maintained by these same municipalities, but they will get a contribution from the government. The law provides, however that, in case of neglect on the part of the municipalities, the Minister of Roads has the right to have the work done at their expense. This does not mean coercion, but it gives to the minister the necessary athority to take the steps that, in his judgment, will bring the desired result—that is, the maintenance in good order of all the macadamized or gravelled roads in the Province of Quebec.

Value of Architecture in Bridge Building

Illustrations of Typical Structures in the Vicinity of Toronto Portray Inviting and Impressive Designs—Standardization Offsets Individuality

By R. O. Wynne-Roberts*

STANDARDIZATION has become an accepted religion, or code, among many engineers in connection with structural designs. Bridges built for highways and railroads are no exception, for standard designs are prepared for given conditions, and, whilst much may be contended in support of such a condition, it is not without its drawbacks. Standardization of bridge design may be conducive to efficiency and to facility of construction, but it cannot be denied that it removes the opportunity for the genius of the engineer to leave his impress of individuality and originality. Furthermore, standardization tends to the multiplication of structures built to uniform design, and if there is one thing that does not appeal to us it is to visually collide with a repetition of structures built on a common plan. Apart from this, suppose it is granted that standard structures lead to economy in cost, it will be admitted that the bridges will remain with us when the expenditures are entirely forgotten.

But economy is not always secured by the reproduction of standard designs, for the cost depends upon circumstances; and if cheapness is to be the only quality kept in view, then the development of the art of bridge-building will be seriously retarded, if not thwarted. The character of the public mind and tendencies may, in general, be gauged by the buildings and structures which they erect. It will, therefore, be a wholly inadequate legacy for posterity if we to-day worship the idol or fetish of the standardization of structural designs and leave landmarks which do not reflect our true character.

Bridges should bear some relation to the surrounding natural features. If the district is strictly industrial, steel bridges will doubtless be suitable. But what would be said if fine buildings are erected on the borders of a lake or stream with a vision of natural beauty marred by a heavy straight-truss steel bridge? Steel bridges have their place of usefulness and suitability, but that place is not everywhere, and yet standardization of steel bridge designs tends to that end. Bridges, like other structures, should, as far as possible, harmonize with the natural features of the locality. The main object of this article is to show a few instances of what has been done without incurring excessive cost.

Fig. 1 illustrates the Buttonville bridge, Markham Township, having a span of 50 feet. This is simple and plain in design, yet the outline is neat.

Fig. 2 represents the Pefferlow bridge, in Georgina Township, having a span of 40 feet. As will be seen, the outlines are broken by semi-columns at the terminus of the arch and the end newels.

Fig. 3 is the Massey bridge, on the Dawes Road, in York County. Its span is 40 feet. This bridge view is submitted to show the effect of pilasters at the abut-

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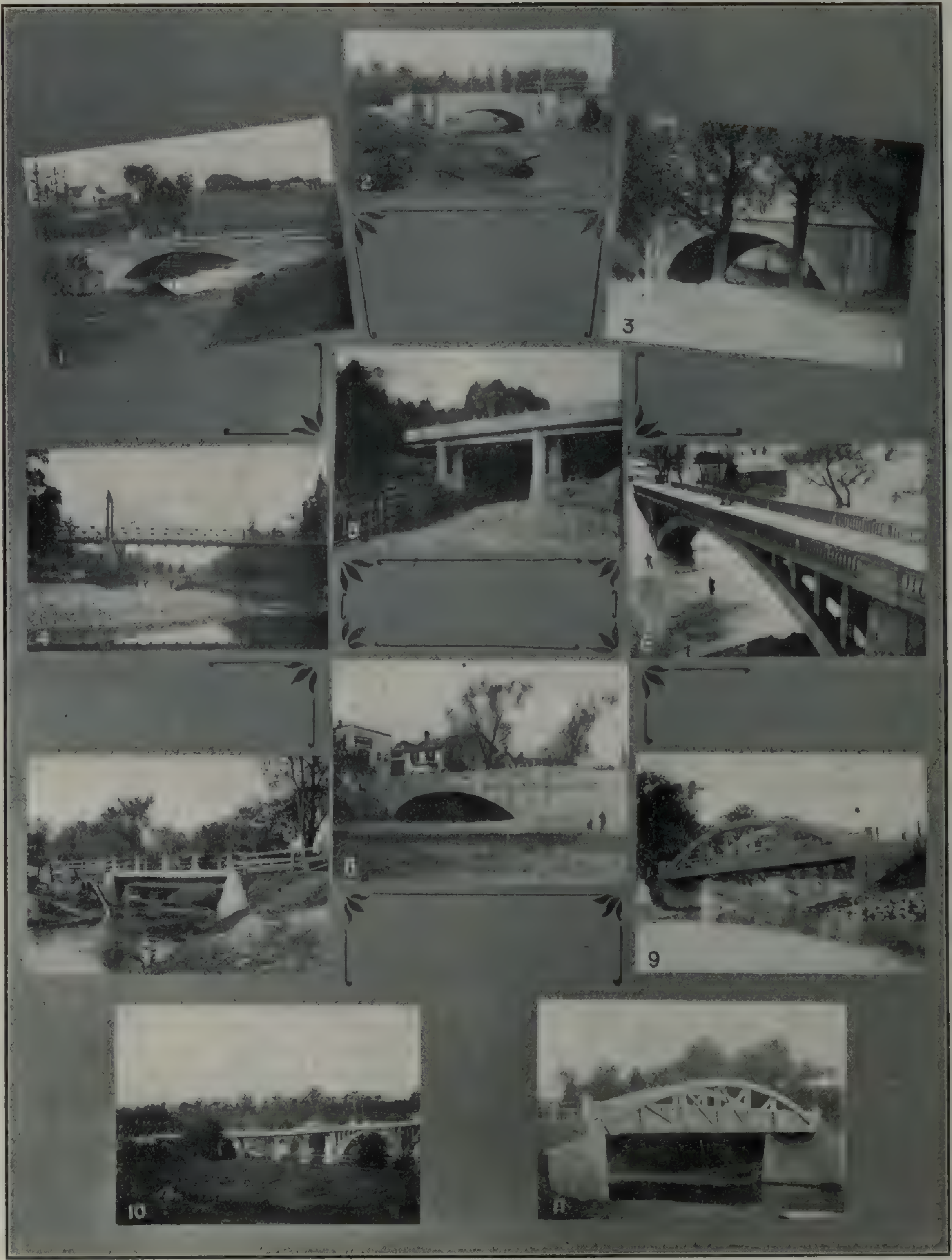
*Consulting Engineer, Toronto



Examples of highway bridges in which pleasing design has been added to engineering skill without appreciable increase in cost.—Built by Frank Barber.

ments, revealing the arch ring outlines and the balustraded parapet walls.

Fig. 4 illustrates the aesthetic effect of a light steel suspension bridge, which was erected over the Rouge River in Scarboro Township. The main span is 100 feet.

Fig. 6 is the Wadsworth bridge, at Weston, which has a span of 118 feet. This illustration is self-explanatory.

Fig. 8 shows the Timothy Street bridge at Newmarket. Its span is 60 feet. This has pilasters and ornamental parapet walls.

Two other views are of flat beam, or girder, bridges. Fig. 7 is the Cold Creek bridge, between York and Peel Counties; it has a span of 35 feet. Fig. 5 illustrates the Bathurst Street bridge, in York Township. The length of the bridge is 130 feet. Reinforced concrete truss bridges are represented by Figs. 9 and 10. Fig. 9 illustrates the Freeman bridge on the Rouge River; it has a span of 91 feet. Fig. 10 is the Middle Road bridge in York and Peel Counties. The span in this case is 80 feet. Attention is drawn to the different treatment of the balustrades.

No. 11 is the Oakville bridge, in the County of Halton. The main span is 135 feet and the total length of the bridge is 476 feet.

All of the foregoing examples of bridges were designed by Mr. Frank Barber, consulting engineer, Toronto, to whom the author is indebted for the above information.

In conclusion, the author submits that bridges should not be considered solely from the utilitarian point of view. The public is slowly coming to perceive that the aesthetic treatment of bridges, as well as of other structures, is a very desirable element. Structures of permanence should afford the users some measure of delight. Picturesque environment should be preserved, and, where possible, enhanced by suitable bridges. This needs no argument, for ugly structures are condemned even by the most ardent advocates of economy. Bridges, then, should be suitably designed, having graceful lines and sufficient relief to create a lasting impression. Utility without austerity and bold outlines without crudity are the essential standards which we should bear in mind when designing structures which are to be constantly in view. Undue ornamentation is, of course, not becoming in substantial or important erections, but the entire absence of art too often renders them crude, bare and uninviting.

Good Roads as Seen by the Motor Tourist

Growth of Automobile Traffic with Resulting Increased Revenues Entitles Motorists to Consideration in Planning Road Construction

By W. G. Robertson*

SIR WILLIAM HEARST, in reply to the good roads delegation which waited on the Ontario Government at the Parliament Buildings, Toronto, on March 1, to request the construction of a transprovincial highway, referred to the importance of the rapidly-growing motor tourist traffic. On a recent trip through New York and the New England States the Premier had been greatly impressed by the multitude of motor tourists which he encountered. One was almost led to believe, he said, that the chief occupation of the people along the great highways in the States was preparing chicken dinners for motorists and supplying them with gasoline and tires.

Increase in Visiting Tourist Traffic

The exchange of automobile licenses between Ontario and many of the states of the United States, which went into effect last year, and the new customs regulation, which permits tourists' cars to remain in Canada for a period of one month without bond, have resulted in a veritable invasion of the Dominion by United States motorists. The number of tourists' cars entering Ontario from the United States last year is estimated to have been 50,000, as compared with 6,000 in the preceding year. Placing the average number of passengers at four per car, the stay of each party one day, and the average expenditure at $5 per person, the amount expended in Ontario by these visitors would be $1,000,000, and this is a conservative estimate. It is evident that the visiting motorist is to be no insignificant factor in the future sources of revenue of the Dominion of Canada, which at the present time offers so much in the way of attractive scenery and so little in the way of improved highways.

Automobile touring in Canada is not confined, however, to foreign motorists. They are but a small percentage of the motor tourists who each summer traverse the highways of the Dominion. There are now close to 120,000 automobiles owned and operated in Canada, and not only is this number increasing rapidly from year to year, but so also is the proportion of automobile owners who make use of their cars for touring purposes. The increase in automobile touring brings an increased appetite and demand for better highways, and the improvement of the highways, inversely, gives a further impetus to automobile touring.

Farmers Adopt the Automobile

It is now idle to say that good roads are only for the motorist, for even if this were true, with 12,000 farmers in Ontario owning automobiles and probably 20,000 more prospective farmer purchasers, of what force would the argument be in that province? The automobile is no longer the vehicle of the classes today, but serves the masses; and, while good roads are not built primarily for motor traffic, no engineer would think of leaving out of consideration as a factor in the construction of highways to-day the motor vehicle traffic which a road may be expected to carry. Traffic census taken in suburban areas throughout Canada and along main highways show that the number of self-propelled vehicles greatly exceeds the number of horse-drawn vehicles, with the proportion increasing from year to year.

In the Province of Ontario, where 55,000 automobiles were owned and operated last year, the government drew a revenue of $650,000 from automobile owners, which, it is understood, is to be available for road construction work. The motorist in Ontario pays a tax of from $10 to $30, according to the horse power rating of his car. The average farmer contributes a good deal less toward road construction, as was pointed out by Mr. C. R. Wheelock, president of the Ontario Good Roads Association, at the annual convention of that body in Toronto last month, the small farmer owning a four-thousand-dollar farm, at the tax rate of 1½ mills on the dollar, paying $6.50 for road improvement work, and the large farmer owning a ten-thousand-dollar farm, paying $15 for road improvement work. Since the motor car has become such an important factor in transportation and the motorists contribute so largely towards the cost of building and maintaining roads, it surely follows that the motorist is entitled to express his opinions on the subject of road construction, and that those opinions should receive due consideration by road construction authorities.

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*Secretary, Ontario Motor League.

Smooth Surface Chief Consideration

The average motorist has no fixed ideas as to what types of construction should be followed in the building of main highways. He is not particular about grades so long as they are not too steep for him to take "on high," and does not in the least mind curves so long as the view is unobstructed, but he does ask for a smooth-surfaced road. He grows impatient at the waste of money when a macadam road gives way under heavy traffic during its first or second years, and "wants to know" why a more permanent type of highway was not constructed in the first place. The motorists of Canada have been closely following the road construction in the United States, and know that as a result of the heavy motor traffic in New York State, for example, the financial burden of maintaining the system of macadam state highways has become a very heavy one, and that the demand is becoming general for pavement surfaces of a more permanent character. The road which will not stand up under heavy traffic because of the cost of maintenance will prove a good deal more expensive in the long run than a road on which there is a greater initial outlay. Not only is there the loss of money, but the great inconvenience of having large sections of the highway closed to traffic during the height of the touring season, making it necessary to follow detours over the worst kind of country roads.

Good Gravel Road Gives Easy Riding

There is a prevalent opinion that the motorist is principally interested in main highways along which he can drive his car at break-neck rates of speed, but this is a misconception. The average motorist prefers the pleasant country byways to the highways, and whenever he finds a fairly good road delights to escape from the main highway, with its heavy traffic and forced rate of travel. There is no road surface which appeals more to the motor tourist than that of a smooth-surfaced gravel road. There is no road which gives easier riding, although, unfortunately, it is not suited to the demands of heavy traffic. The motorist, therefore, is interested not only in seeing the main highways brought up to a high standard, but in the improvement of the less-travelled roads. Where material is abundant in many sections of Canada gravel roads can be built and maintained at a very low cost, and with proper ditching and draining and the use of the split-log drag, wonders can be achieved with common dirt and clay surfaces.

High-crowned roads do not meet with the favor of the motorist, for in wet weather they are always treacherous, and the passing of another automobile or rig becomes an acrobatic feat for the occupants of the car. If there is anything worse than the high-crowned road from the motorist's point of view it is the country highway on which loose crushed stone has been piled in the centre, to be beaten down by traffic, or the road where loose sod has been thrown to the centre of the road in the process of grading. There are, of course, the unimproved roads without sufficient drainage, which are impassable for the greater part of the spring and fall, but these, properly speaking, are not roads at all, but merely road allowances. This same so-called highway, which is impassable in the spring and fall, in the summer lies covered with inches of dust, and if there is anything the motorist hates worse than mud it is dust. The municipality which lays the dust by oiling its roads confers a boon on the motorist, for which he is duly grateful.

"Bump" Where Road Meets Bridge

If a motorist were to have a heart-to-heart talk with a county road engineer he would almost certainly call his attention to the need of specially constructing the road at the point where it meets a bridge or culvert, so that the depression may be eliminated which so often results in the breaking of car springs and the near-breaking of the necks of the car occupants.

No modern highway is complete without proper signs, which should be illuminated at night, warning the motorist of the proximity of railway crossings, cross-roads, steep grades, and sharp turns. These signs should be of a conspicuous character, and should be plainly lettered and judiciously placed so as to attract attention, at least 300 feet from the danger point. All bridges and guard-rails should be painted white, as they are thus made visible at twice the distance at night. In the larger cities most automobiles are now used all the year round, and the main highways between cities at least should be kept free of snow during the winter, to permit of interurban travel. With very little effort the Toronto-Hamilton highway was kept open to traffic all last winter, and it is thought that by the erection of a few snow fences the formation of drifts will be prevented and the road kept open to winter traffic without the necessity of removing snow from the highway.

Only one sort of sign should be permitted to be erected along main highways—the direction sign. The decision of the Toronto-Hamilton Highway Commission to prohibit entirely the erection of advertising signs along the highway is to be commended to all road authorities.

Road Information Bureaus Very Helpful

The maintenance of road information bureaus supplied with accurate data regarding temporary road conditions through the advice of members and road scouts is an important public service, for which the automobile club has special facilities. The best use can be made of highways only through the possession by the parties travelling on them of accurate information as to their conditions. The service of the automobile club's information bureau is supplemented by special maps and road guides, giving descriptions and cyclometer readings of the main travelled roads. In erecting numerous direction signs and danger signs where reqired, automobile clubs supply another real need on the part of all who travel on the highways. These signs are recognized and protected by law in Ontario. In this work of making available the actual road resources of the country the automobile clubs perform a valuable public service.

Better Highways in Ontario Province

The Third Annual Conference of Road Superintendents and Engineers to Discuss Best Methods of Construction and Maintenance — Keen Interest Shown by Large Attendance and Animated Discussions

THE county road superintendents and engineers of Ontario held their third annual conference on road construction on March 27-30, at the Parliament Buildings, Toronto. This conference, held under the auspices of the Ontario Department of Public Highways, included representatives from all the counties of Ontario undertaking highway improvement work under the "Highway Improvement Act." In opening the sessions, Mr. W. A. McLean, Deputy Minister of Highways of Ontario, explained the object of these annual conferences. It was the aim of the department to secure uniformity of methods and personal co-operation between the departmental engineers and the road superintendents of the various municipalities throughout the province. These annual conferences have proved a highly successful means of obtaining such uniformity and co-operation. They have been held just previous to the opening of the construction season, so that ideas obtained at these meetings would remain fresh in mind when the superintendents returned to their respective communities to open the construction season. The prime purpose in instituting these conferences was to secure an interchange of ideas on road construction, since it was felt that by informal discussion the exchange of experiences would prove most beneficial. The result is to give road superintendents a broader understanding of their work and bring the various officials into intimate touch with one another so that their ideas may not be too much restricted or limited.

New Legislation Outlined

The Hon. Finlay Macdiarmid, Minister of Public Works and Highways, outlined the new legislation that would be enacted at the current session of the house, stating that it was the intention of the province to set aside certain roads as provincial highways, and the province would contribute a very great proportion to their construction and maintenance. The idea of this legislation was to relieve the local municipalities from performing work for the benefit of other counties, since the roads set aside as provincial highways supported chiefly through traffic and hence would not be to any great extent local in character.

The opening paper of the conference was on "Departmental Requirements Regarding Annual Returns," read by Mr. W. Huber, assistant engineer of the Ontario Department of Highways. This paper outlined the records and annual statements of expenditures on highways which are required by the department from those counties to which a provincial subsidy is granted. A specific manner of making these returns is required, and Mr. Huber outlined the proper manner in which to obtain data, and also indicated a simple system of recording costs on county highway work.

In the discussion which followed, various superintendents expressed their approval of the system outlined by Mr. Huber, but in applying the methods they had found difficulty in obtaining the standard forms, and urged the departmental authorities to have these prepared so that their use might become more widespread. One of the greatest difficulties in obtaining accurate costs and collecting data of this nature was experienced in getting the foremen to fill out the forms and classify the work in proper shape. Mr. Wilson, of Halton County, and Mr. Millen, of Essex County, had had considerable difficulty in this regard. They found that the foremen did not follow the distribution system as well as might be, but felt that with a little experience and training they could probably be enlightened. Mr. Blackwell was in harmony with the standardization of accounts, and advocated printed forms. Mr. Millen, of Essex, favored a uniform system of books. The road system in Haldimand County, according to Mr. McBurney, is divided into 40 divisions, for which 40 individual accounts are kept. The work in this county is discussed with the foremen before construction starts in the spring, and this conference has been found to be of very material benefit. The foremen are allowed mileage in order to attend this meeting. Mr. Anderson, of Lennox and Addington Counties, follows the departmental scheme in the main. He suggested that accounting be made imperative with the foremen.

Transportation a Vital Consideration

At the afternoon session on March 27, Mr. George Hogarth, chief engineer of highways, read a paper on "The Transportation of Materials," outlining the various methods of hauling material, and pointing out that economical haulage is of vital importance in the reduction of the cost of roads. Mr. A. A. Smith's paper on maintaining earth and clay roads described maintenance features of a type of road which is most predominant in the Province of Ontario. The various types of culverts, with special reference to the departmental standards, were described in a paper by Mr. Arthur Sedgwick.

On March 28, Mr. George Hogarth, chief engineer of the department, described the standard plans and specifications of steel bridges and concrete culverts which the department had prepared, and which are available for the use of county road superintendents and engineers. These standard plans have been prepared with the idea of eliminating chances of failure due to poor design and are by no means compulsory, but are merely suggestions of acceptable designs, and do not by any means eliminate the engineer. Plans and specifications are included for steel bridges from 20 to 120 ft. span, with 16 and 18 ft. roadways, and for culverts from 1 ft. to 20 ft. span.

In commenting on the plans, Mr. Talbot, of Middlesex, believed the idea was excellent, provided latitude is allowed in securing economy. Mr. Hogarth emphasized that these were merely suggestions to indicate something along a general line, and need not be followed literally. Mr. Talbot did not see why townships are not required to submit their bridge plans to the provincial department, as were the counties. Mr. E. A. James, of York County, felt that townships would be willing to submit their plans if a provincial contribution were given. Mr. Robertson, of Lincoln County, pointed out the difference between township and county systems, since the province subsidized the work performed by the latter. A question was asked regarding the life of a concrete floor as universally indicated in the standard plans of the department, to which Mr. Hogarth replied that, with good materials, a practically permanent floor was obtainable, his experience having been that there are floors of 1:2:4 mix without a mark after eight or nine years. Mr. Talbot, of Middlesex, had also seen perfect floors, although built as early as 1898. Provision for expansion in the slab elicited some comment, some of the superintendents taking exception to the pitched joint as provided in the departmental plans. Mr. Talbot's practice was to carry the slab directly over the mud fill, and Mr. James usually sloped the ballast wall. Bridges strong enough to carry concrete floors were advocated by Mr. Campbell, of Simcoe. His county had built many bridges, and found no difficulty with concrete floors. The matter of cast iron pipes for culverts caused some discussion, Mr. James stating that many municipalities had had trouble with them, due to freezing. Mr. Wheelock, of Peel, felt that the standardization of plans, such as the department had arranged, would result in the building of bridges at the minimum cost. He believed, however, that bridge building would be improved by competition and standardization in too great a degree, by eliminating competition, might tend to result in a poorer class of structure. It, further, in his opinion, prevented individuality in appearance. The lack of proper supervision in the erection seemed to him the biggest difficulty. In Wellington County, Mr. Young stated that everything was of concrete where possible. The first concrete floor had been laid in 1905. With the exception of one, all floors of this material have been perfect. One floor in Halton County, according to Mr. Wilson, has lasted twelve years, another only three weeks. The latter failed because the bridge was not strong enough to carry the floor. In his opinion, foundations must be built deep enough, as he had experienced some failures due to shallow footings. Proper mixing and correct water proportioning were urged by Mr. Fair, of Frontenac.

Mr. G. C. Parker and Mr. W. Huber read papers on "Dust Preventives and Bituminous Binders" and "Important Details in Oiling and Tarring" respectively.

Superintendents View New Highway

On March 29, in the forenoon, the superintendents, through the courtesy of the Toronto-Hamilton Highway Commision, were taken over the new Toronto-Hamilton highway and shown the details of construction in this important work.

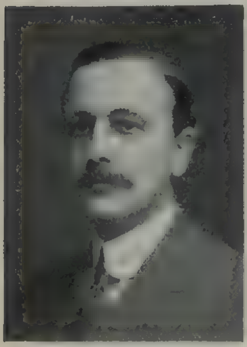
In the afternoon Mr. W. H. Losee discussed "Safety Measures on Our Highways," and Mr. R. M. Smith outlined acceptable methods for repairing gravel and stone roads.

The morning session of Friday, March 30, was taken up with a discussion of increasing efficiency and reducing construction costs, as outlined in a paper by Mr. W. Huber. Mr. W. A. McLean, Deputy Minister, presented a resume of the highway laws of Ontario, describing the growth of road legislation in the province and outlining the improvements that have taken place, culminating in the acts at present on the statutes. The legislation promised for this season was described, Mr. McLean emphasizing that the increased subsidy which the province intended to give in connection with the formation of provincial highways was merely a compensation for the higher type of construction which the county authorities would have to provide for. This subject elicited a very copious discussion, showing that the road superintendents of Ontario are keen for information regarding the new scheme.

The closing session of the conference was taken up with a discussion on road foundations and drains in a paper by Mr. R. C. Muir, and a description of some of the methods used on the Toronto-Hamilton concrete highway by Mr. H. S. Van Scoyoc, chief engineer, Toronto-Hamilton Highway Commission.

The Transportation of Materials

By George Hogarth, A. M. Can. Soc. C. E.*



Mr. George Hogarth

IN the construction of highways where a surface of a more or less permanent character is to be prepared the moving of the construction materials to the site of the work deserves the closest attention of those in charge. This applies to sand-clay road construction, also to the building of gravel and macadam roads and pavements of concrete or bituminous materials, since in each of these types of construction a great deal of hauling has to be done. For the gravel and macadam roads, gravel and crushed stone must be moved in fairly large quantities; for the bituminous pavements, crushed stone and bitumen are required, while for the concrete pavement, sand, crushed stone and cement are essential.

In laying out the work of road building the sand or gravel pits or stone quarries from which the materials will be secured are probably located so that wagons can be loaded at the plant and despatched directly to the road. At times material may be secured from distant sources of supply which will require that the railways deliver the cars at stations convenient to the road. A proper selection of unloading points will facilitate construction, and due regard should be given to the choice of roads leading away from the railway stations in order that serious damage to the surface of such roads may be avoided.

Rapid Loading Important

An important point in the handling of all materials is to see that the loading and unloading of all wagons is carried out with the least possible delay. At the loading end, bins may be made use of, since by that means a wagon is easily and rapidly loaded. This avoids delays to the teams and a better showing will be made in the daily tonnage hauled. The manner of unloading the wagons also calls for some care, and the type of box used will to a great extent determine what can be done at that end of the work. There are two types of wagons used for hauling, the flat bottom wagon and the bottom dump wagon. The bottom-dump wagon seems to be in general use to-day as it has been shown to be the handiest for quick unloading.

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* Chief Engineer of Highways.

Where materials are moved by power, such as on industrial railways or with tractors or motor trucks, it is necessary that well-equipped yards be provided to facilitate rapid loading and handling. Large storage bins will be required so that on arrival of empty wagons an ample quantity of material can be quickly loaded by gravity. If bins cannot be provided, then mechanical means should be obtained for loading and a crane installed. A large saving can usually be effected by careful attention to the quick loading of the wagons.

No matter how small or how large the work in hand may be, the superintendent should endeavor to keep an accurate check on the work done in order to arrive at the cost of the hauling. Cost data is very useful in preparing estimates and in comparing the work of different gangs or outfits, and every opportunity should be taken to arrive at the cost of the various parts of the work. Each superintendent will find that his charges for doing the same kind of work will probably vary from those of his neighbor doing exactly the same work, and the investigation pursued in finding out the reason for any large differences will usually result in certain reforms or betterments being made. By all means keep cost data, as it is the only way in which the work can be proved to be efficient.

Hauling by Teams

For the greater percentage of road construction to be carried on for some years there is no doubt but that we must depend upon teams for the hauling of all material. Teams furnish a slow method of transportation and have a number of advantages and disadvantages. In some cases it might be found advisable for the county to own a few teams in order to set the working pace, and always have teams available when wanted. When purchasing a team buy only the best horses, and see that they are properly looked after. While a county might own a few teams, it is usually advisable, for economic reasons, to hire locally whatever other teams may be required. That is one advantage of teams, they can be obtained almost everywhere in sufficient numbers to do almost any ordinary job, and where a job is of small proportions it can be done most economically with teams hired at the site. Teams do their best work during summer, when the temperature is moderate, and when the roads are dry and in good condition for hauling. When hot weather arrives, teams will be found to slow down in pace and to tire more readily, so that rest periods must be provided. That is a disadvantage possessed by teams and is a weakness to which mechanical transport is not subject.

The cost of hauling materials by teams will be effected by the state of the weather, by the kind of roads over which teaming is carried on, by the nature of the country, whether hilly or level, by the capacity of the team for work and by the rate per day paid for teams. In view of the number of important factors entering into the cost of hauling by teams it will be seen that costs may differ considerably in various parts of the country. On ordinary roads it will be found that a team will average about twenty miles per day for round trips, or, say ten miles per day with a load. Over easy grades a team should be able to move from 1½ to 2½ tons at a load, or an average of, say, 2 tons hauled ten miles at a cost of $5.00 per day. The cost of hauling by team is, therefore, on an average about 25c per ton mile.

Mechanical Haulage

Where a large system of roads is mapped out for construction and the building of those roads may extend over a term of years, the question of hauling by mechanical means should be examined into and an estimate of cost made of using such machinery. The types of mechanical haulage available to-day are as follows:—1. Road rollers; 2. steam tractors; 3. motor trucks; 4. industrial railways.

In estimating on using any of these means of hauling, a number of vital points enter into the calculations. One of the most essential details to the estimate is the first cost of the equipment. In order to arrive at the cost of moving the unit one ton, one mile, or the ton mile, as it is commonly known, it will be necessary to consider the annual cost of the equipment, which will be the total of the interest on the investment, depreciation per year, cost of repairs, operating charges, and the superintendence. The total of that sum divided by the number of ton miles hauled per annum will show the cost per ton mile.

Road rollers are in some cases used for hauling, but, because of slow speed, they are not economical. However, in an emergency they may be of considerable use.

Use of the Steam Tractor

Steam tractors capable of hauling a train of five or six dump cars have been of use in road construction. The first cost of one outfit consisting of one tractor and five cars is about $3,700, and the annual charge is in the neighborhood of $4,100. In working 150 days per year the machine should move on an average about 30,000 tons one mile, so that the average cost of hauling by this means would be from, say, 7c to 10c per ton mile. These figures are based on 6 per cent. interest on investment, a depreciation of 15 per cent. per year, repair bills of 5 per cent. per annum, operating charges $6.75 per day and superintendence 5 per cent. The steam tractor is usually easily kept in a good condition of repairs; is of simple construction, with strong details, and may be operated by almost any intelligent mechanic. The figure of 7c to 10c per ton mile is calculated upon operating the engine for 150 days per year, and on any ordinary job it is possible to obtain efficient operation and costs as low as those quoted.

This low cost of hauling is made possible by the use of probably five or six trailers, each of which may have a capacity up to four yards or more. Such a train will be in charge of two men, and 25 or 30 tons would be hauled per trip. On short hauls with good roads and no hills a very low rate for hauling by this means would be obtained.

Motor Truck Haulage

Hauling by means of motor trucks has come into general use in the cities during the last few years, and to-day nearly all tradespeople and warehouses deliver and transport their goods by motor truck. In view of the popularity enjoyed by the motor truck for this class of work it is advisable that we look closely into its methods of operation and costs for building roads in the country.

One advantage enjoyed by the truck in the city is that everywhere good pavements are found, and a low powered truck is able to move a large load satisfactorily under all weather conditions and practically for 300 days per year. Such pavements are ideal for truck operation.

It is well to point to this fact and also as a comparison to call attention to the general state of country roads during spring, autumn and winter months of the year, when impassable conditions exist. For hauling by truck in the country it is believed that 150 working days per year will be about the maximum that truck operation is possible. The capacity of truck to purchase is important. Practically every size from 1 to 5 or 6 tons is manufactured and sold to-day. The heavier truck is seen at its best when operating over good roads, but for general hauling purposes the lighter truck will give better satisfaction, and experience indicates that the 3 or 3½ ton truck is the largest capacity that should be considered. The military authorities favor 1½ and 3 ton trucks, and these sizes have given satisfaction over what are described as horrible roads. Contractors on road work in the United States claim that a 5 ton truck will usually spend a good deal of time extricating itself from ruts or broken bridges or culverts, and during wet weather pulling itself out of the ditch. They have had trouble with the heavy truck, and to-day they believe the 3 or 3½ ton truck is the best to use. For one reason or another the heavy truck is frequently delayed on the road. Delays to such equipment decrease the efficiency greatly, as in order to get proper results a truck must be operated continuously.

Length of Wheel Base a Consideration

In operating a truck on road construction it is often impossible to choose turning places, and in some cases turns must be made in very close quarters. For that reason it is well to consider the wheel base of the truck being purchased. A long wheel base may prove awkward. With a truck having a wheel base of 124 inches it is possible to turn around on a 12-ft. road with a sand shoulder.

In road construction one 3½ ton truck will usually replace six teams, and with that data and some experience in the operation of trucks it is possible to estimate the cost of motor truck hauling. It will usually be found that on road construction the cost of tire renewals is fairly high and will amount to 5c or 5½c per mile of run.

An estimate of hauling by 3-ton motor truck based on 150 days operation per year is as follows:—

Cost of truck		$6,000.00
Annual Cost—		
Interest on investment 6% on $6,000....		$ 360.00
Depreciation per year 20%		1,200.00
Repairs		200.00
Operating charges—		
Chauffer 6 months at $80.....	$480.00	
Gas and oil $4 per day	600.00	
Tires	375.00	
		$1,455.00
Superintendence 5% of $3,215 ...		160.75
Total		$3,375.75

In one season's operation under favorable conditions the truck will haul about 20,000 ton miles at a cost of $3,375.75, or 17c per ton mile.

Such a truck may be good for a life of more than five years, and in some cases ten years is the economical life of well-built trucks, so that the cost per ton mile for moving materials by motor truck will probably be from 12c to 15c per ton mile.

Haulage by Industrial Railway

Narrow gauge industrial railways have been used for years in the operation of coal mines, and our steam railways of to-day are a compromise between the narrow and broad gauge of fifty years ago.

Industrial railways are adapted to the haulage of large quantities of material required in important undertakings, and their use may be particularly advantageous for road purposes under certain conditions. Points in their favor are that they can run over soft ground wherever a track two feet wide can be laid; they do not rut or tear up the road over which they operate, and wet weather has little or no effect on them.

Light rails having a weight of about 20 pounds per yard are used, and these are fastened to steel ties by bolts and clips, so that two men can handle a section of track. The cars used are usually steel and of V-shape, having a capacity of about two tons and arranged so as to dump to either side of the track. The cars weigh about 1,000 pounds, and, depending on the grades, 16 to 30 loaded cars may be hauled in a train. By this means 32 to 60 tons of material are moved to the destination at one trip and at a speed of from five to eight miles per hour. As a long haul outfit the industrial railway is to be recommended, but the investment necessary to provide the equipment is many times the cost of any other method of hauling.

The outfit will usually require a length of track from 6 to 18 miles, and the total first cost of track, locomotives, care and accessories will be anywhere from $35,000 to $60,000.

With such a large investment there is a heavy charge for interest and depreciation, while at the same time overhead expenses, operating expenses and incidentals may be heavy. The cost per ton mile for moving material by this means may be anywhere from 17c to 25c per ton mile.

Such a railway on a large work will frequently prove economical, but in order to do so, efficient operation is required and a heavy expenditure for yards and quick loading apparatus must be incurred.

Discussion on "Transportation of Materials"

Mr. McLean, Deputy Minister of Highways, in replying, emphasized the importance of haulage, and pointed out that the expense attached to this item alone was proportionately greater in many cases than any other factor in road construction. Personally he was partial to steam tractor transportation, inasmuch as this particular form appeared to introduce efficiencies not evident in horse or truck haulage. It was very important that economies be devised in team hauling because horses have, for the most part, been workat only half efficiency. In his opinion, wagons of four or five cubic yards capacity are too heavy. The cost of hauling is a most important matter, and efficient means must be devised, as in many counties the greatest expense attached to road construction falls to the transportation of materials.

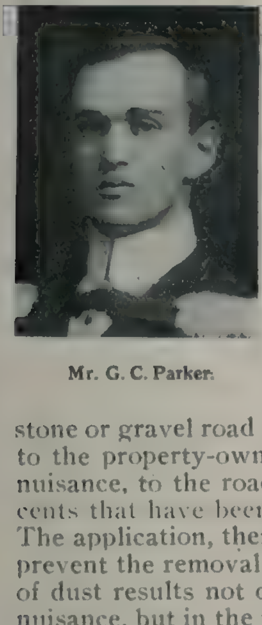
Mr. Van Scoyoc, chief engineer of the Toronto-Hamilton Highway Commission, outlined his experience with industrial railway transportation on the Toronto-Hamilton highway. This form of haulage was made necessary on account of the large quantities of materials to be handled. To do the same work it would have required 200 teams, and the difficulties in controlling such a means of transportation are very evident. Side roads adjacent to the route of the Toronto-Hamilton Highway were almost impassible for heavy motor traffic, so that industrial railway haulage was practically forced on the Commission. It undoubtedly was the cheapest way of handling the materials in this case, since 500,000 ton-miles represented the total amount hauled. In some instances track haulage with horses was employed, but the cost was 12 to 14 cents per ton mile, against 5 to 6 cents with steam locomotive haulage. An advantage that was realized with the industrial railway was that the work was carried on regardless of weather conditions, and it enabled day and night shifts to be employed, although night work was slightly more expensive than day work. The unloading of the materials for his highway was by crane, using three yards, allowing an average haul of three miles. This method was found more reasonable than hand unloading, the cost being 5 to 6 cents a ton. Mr. Van Scoyoc limited the application of train transportation to large undertakings only, where the quantities of materials to be handled were extensive and the total expense justified large capital outlay for train equipment.

Mr. McBurney, of Haldimand County, described steam traction haulage in his county. A steam tractor with dump wagons has proved a very efficient aid in building this county's road system.

Wentworth's county road haulage, according to Mr. Allison, was done entirely by team.

Dust Preventives and Bituminous Binders

By G. C. Parker, A. M. Can. Soc. C. E.



Mr. G. C. Parker.

It is not the purpose in this article to discuss or promote discussion on the technical points connected with the selection and use of dust preventives and bituminous binders, but to approach the subject from the standpoint of the road builder, a person whose time is too fully occupied with other matters to pay any attention to the complicated problems involved in the production or chemistry of these materials.

The presence of dust on a stone or gravel road is an indication of wear; and, while to the property-owners along the road it is a decided nuisance, to the road builder it represents dollars and cents that have been paid for crushed stone or gravel. The application, therefore, of some medium which will prevent the removal of the powdered stone in the form of dust results not only in the elimination of the dust nuisance, but in the prolongation of the life of the road.

Two general methods may be followed—the frequent application of light, inexpensive materials, the effectiveness of which is only short-lived, or treatment with a heavy material containing a non-volatile base or residue which remains on the surface of the road or is incorporated in the wearing course.

For the purpose of discussion we will consider the materials under the four general headings: Dust palliatives, protective mediums, carpeting mediums, and binders.

Dust Palliatives

Palliatives, as the name implies, are primarily for the purpose of retaining the dust on the road surface rather than for the prevention of its formation. They should be quite fluid in order that they may be applied without heating and that they may spread over the surface in a thin, even layer and hold the particles of dust together without impregnating the surface of the road. It is not necessary that they possess binding qualities nor that, when applied this property be developed. We need not consider water, salt solutions, granular salts, emulsions, nor non-asphaltic oils. Frequent applications are required for effectiveness, and for this reason their use is confined to park and suburban roads, their place being taken on rural highways by materials of which not more than one application per season is necessary. Asphaltic oils when containing more than 20 or 25 per cent. of asphalt cease to come under the category of dust preventives, and take on the nature of protective coatings.

Protective Coatings

When a road is required to serve a small proportion of motor traffic it is necessary to use a material which not only retains the dust, but forms a protective film over the road surface, and which resists the combined action of horse-drawn and motor traffic to a greater degree than ordinary palliatives.

Protective coating materials should be fluid at ordinary temperatures, in order that they may be applied cold and that they may spread uniformly. They should contain a small amount of volatile oils which evaporate, leaving a cementitious film on the surface. A large percentage of volatile matter is objectionable, particularly if, in evaporating, it leaves a residue which becomes hard or brittle on exposure. Light, refined tars which are fluid at ordinary temperatures and are easily applied, as well as asphaltic oils containing from 40 to 55 per cent. of asphalt, have given satisfaction in this class of work. The amount applied should rarely exceed one-fifth of an imperial gallon per square yard, and excessive amounts are to be strictly avoided.

Carpeting Mediums

When the proportion of motor traffic is so great that the protective coating is destroyed, a thin mat or carpet of bituminous material has been found effective. The tendency for the horses' shoes and the steel tires to cut up the surface is overcome by the ironing action of the rubber tires of the motor vehicles.

Carpeting mediums are applied hot, being immediately followed with a coating of stone screenings, pea gravel, or coarse sand. When properly applied, the result obtained should be a thin mat or carpet on the surface of the road, consisting of the bituminous material and the mineral matter. At ordinary temperatures, carpeting mediums should be viscous, but not fluid, in order that they will spread in a comparatively thin layer and not chill and solidify in a thick mat on striking the cold surface of the road. They may or may not contain a small percentage of volatile matter, but this will depend on the nature of the material used. Shortly after application they should develop a degree of cementitiousness, forming a strong bond between the road surface and the mineral coating.

Asphaltic oils containing from 60 to 80 per cent. of asphalt and refined tars containing few or no constituents distilling at a temperature lower than 170 degrees C. are effective as carpeting mediums. Although the amount of material to be applied will vary according to the condition of the surface to be treated and the nature of the material used, from one-third to one-half of an imperial gallon per square yard may be considered an average application.

Incorporating Bituminous Materials in the Surface

Where the proportion of motor traffic is so great that protective and carpet coatings are ineffective it becomes necessary to incorporate the bituminous materials in the wearing surface. Two methods are used. In one, the road is built as in the case of water-bound macadam construction, and prior to the application of the screenings the bituminous cement is applied to the surface, either by pouring or under pressure, filling the voids in the top course of the road. This is known as the penetration method. In the mixing method the stone forming the top course of the road is mixed with the bituminous cement, spread on the foundation, and rolled. This method of construction, however, is beyond the scope of this paper, and is only mentioned in passing. The penetration method, on account of the small outlay necessary for plant, is particularly adapted to use on rural highways.

Penetration materials are solid at ordinary temperatures, and consequently must be heated before they can be manipulated. As previously stated, they are applied by gravity from pouring-cans or tanks, or under pressure from specially-constructed distributors, as in the case of all materials which require heating. They should, consequently, be of such a nature that they will not ignite at the temperature to which they must be heated in order to render them fluid, nor should they undergo any change in characteristics due to such heating. On cooling in the road surface, they should return to their original state, forming a strong bond in the surface of the road. The point of greatest importance in the selection of material for this work is the choice of one having the proper consistency when cold. This property should be specified with due consideration of the size of the stone, the proportions of the various sizes present, and the character of the traffic which will be carried by the road.

Heavy asphaltic oils, oil and fluxed native asphalts, and heavy refined tars are used in the penetration method, the grade used being governed by the conditions mentioned above.

Asphalt and Tar Emulsions

For repair of bituminous surfaces there have recently been developed asphalt and tar emulsions. They consist of the ordinary bituminous material, with the addition of a small amount of alkali, which renders the material miscible with water. When received from the manufacturer the material is thick, and contains only a small amount of water, and is mixed with an excess of water on the road and added to the loose stone. The mixture is then tamped into holes and depressions, and in a short time hardens, taking on the same characteristics as the surface of the road. The transforming of the bituminous material into an emulsion renders possible the patching of the road with a material corresponding in consistency to the material that was used on the construction of the road without preheating. Emulsions should not, however, be used without a thorough investigation as to their effectiveness.

Specifications for Bituminous Materials

A discussion on bituminous materials would be incomplete without mention of the formulating and use of specifications under which the materials are to be supplied. As in the purchase of other manufactured materials, the use of specifications is to be strongly recommended, and is to be urged for the same reasons as those which have caused the universal use of specifications in the purchase of cement, steel, and other materials of construction. The first and most important word of warning in connection with specifications for bituminous road materials is that against the attempt to formulate a specification from a number of others, picking out some clauses from this one and some from that. The properties of the materials are closely interrelated, and the adoption of one clause from one specification may render those from another impossible of fulfillment. In the second place, do not assume that all specifications will cover the materials that are wanted for any particular class of work. The virtue of a specification lies in the results that are obtained from the use of materials purchased thereunder. Investigation should, therefore, be started from this point, and, when successful results have been found, one can be reasonably sure that, conditions being the same, the specifications under which the materials that gave the satisfactory results were purchased are safe to use.

Discussion

Mr. E. A. James, the engineer of the York Highways Commission, outlined the oiling procedure on the roads under his supervision, pointing out the importance of oiling in preserving and maintaining the surface. At first the roads of York County were oiled with a cold light oil; then a heavier oil was applied hot, using gravity sprayer. Later a bitumen was sprayed by a pressure sprayer, and two years ago the system that was adopted was to sweep the road very clean and apply a bituminous coat, covered with sand, thus forming a carpet coat. This has been found to be very effective as a dust preventive and a surface binder. Last year, for the first time, this process was applied to gravel roads, with considerable success. The matter of applying dust preventives and bituminous binders offered a field for experiment, the exact methods to be decided by careful study of the conditions applying in each particular case.

In Wentworth County, according to Mr. Allison, a light oil is not used where a long haul is necessary because several coats of such an oil are required each season. If the haul is long, a heavy oil is employed, since the coating lasts one and a half or two years.

Mr. Robertson, of Lincoln County, stated that roads in his locality are oiled because of the danger of dust damage to the valuable orchards adjacent to the highways. A few dollars spent in laying dust saved many hundreds of dollars' worth of damage to peaches and other crops. His county is trying out types of dustless roads, especially tar macadam and asphalt. One very efficacious remedy for filling depressions was a tar cement, used in Lincoln County, mixed like concrete cement. This mixture of tar and stone, when applied to the depressions, cold-tamped and ironed by traffic, formed an extremely satisfactory method of levelling any unevennesses in the road surface.

The Design and Construction of Culverts

By Mr. Arthur Sedgwick

Mr. Arthur Sedgwick

A CULVERT, being much smaller and simpler than even an ordinary bridge, its cost will be proportionately less, but the number of culverts required per mile of road makes the total cost thereof as high as or higher than the cost of our bridges. To reduce the cost and improve the methods of construction requires the constant careful attention of the municipal official responsible for their construction and maintenance.

I believe it is customary for the county and municipal officials to go over the roads in the spring of each year, to examine the bridges and larger culverts and order the immediate reconstruction of such of them as they find in an unsafe condition. This procedure is almost imperative since a collapse of one of these structures would probably entail very serious consequences.

Smaller Culverts Often Neglected

It would be better if the same practice were adopted for the smaller culverts, but unfortunately these are generally left untouched in each case until somebody reports that they have been washed out or the top has broken in. When this occurs it is of course necessary that a new culvert be built immediately. Since it is important that the road be not blocked any longer than is absolutely necessary, it frequently happens that the culvert is hastily built without regard to cost or for what is required to make a durable and satisfactory job.

It must be conceded that the expected additional life of such of our old wooden culverts still existent cannot be appreciable and therefore little or nothing is gained by allowing them to remain until failure takes place. Besides, there is always the risk of accidents to be considered.

Where these precautions are not taken, and the culverts are left until failure takes place, there is a natural temptation to save time by putting in a large pipe where the size of opening and natural conditions would otherwise suggest a concrete box type of construction being used.

Concrete or vitrified clay pipe should not be used for culverts where there is a danger of water standing in them and freezing. Neither should they be used unless an earth fill at least two feet in thickness can be provided over them. Otherwise they will become cracked with the frost and ice and become displaced by the weight and impact of the traffic on the road. Corrugated iron pipe, especially the larger sizes, should also have plenty of fill over them, or they will bend and become distorted under the loads passing over them.

Fill Must Be Well Compacted

The chief precaution to be taken in using any kind of pipe culvert is to thoroughly compact the earth around it, especially around the lower half. To this end the trench should be dug wide enough to permit an iron ram to be used to compact the filling underneath. If this is not done the pipe may break or bend from the pressure above, or the water may find its way underneath and by freezing force the pipe out of position or may eventually cause a "washout."

To prevent the water from undermining the ends of the culvert and working a passage through on the outside, end walls preferably built of concrete should be provided; or, where corrugated iron pipe is used, end walls of the same material may be used. It should be remembered, though, that these iron culverts cannot be expected to last indefinitely.

Pipes over three feet in diameter should preferably not be used. They are clumsy to handle and are apt to crack or bend sooner or later no matter what precautions are taken. Square box masonry culverts will give better satisfaction even though the first cost be greater.

Where one is sure the ditch or watercourse will not require deepening, such box culverts where they are not over four feet square, can be built with a reinforced concrete floor and a considerable saving of material result. Otherwise, the sides must be carried down to footings reaching below the frost line. The floor sides and top can be built of concrete about one foot thick and reinforced. For such sizes of culverts, wire mesh or expanded metal make a convenient form of reinforcement. Such a type of culvert will give permanent results at a very reasonable cost.

Square Culverts Afford Larger Waterway

Square built culverts give a larger waterway than a circular one of the same width. With a circular section, the water has to rise to some height before there is any appreciable volume of discharge. This is an important factor in flat drainage areas where it is most desirable to keep the level of the water in the drains as low as possible. Again, during abnormal flood conditions, the natural watercourses expand in width and thus provide for themselves an unusually large area of waterway. A circular culvert reduces in width very rapidly above the centre line. It will be seen, therefore, that under such flood conditions there is a tendency for such culvert to restrict the flow of water and cause it to rise still higher.

Culverts less than fifteen inches in diameter should not be used, as they are apt to become blocked with sediment, ice, or coarse debris from the road-side.

Moderate sized culverts are not readily discernable to motor vehicle drivers, and they should therefore be built the full width of the road grade. The required safety thus ensured is well worth the moderate additional cost entailed.

Danger of Unprotected Culverts

In one township the reeve put in some concrete culverts. He insisted that fourteen feet was an ample width of roadway over any culvert. No end walls were provided, and to-day, on most of these, at least one length of pipe at each end is smashed and the opening partially filled up. Only those who know these roads can safely travel over them. What would happen if there was any considerable volume of auto traffic can easily be imagined. The case above cited is an extreme one, but there are numerous other instances throughout the province where accidents are bound to happen sooner or later.

Culverts that are not built the full width of road-grade should be provided with strong guard-rails of such size and type that they may be readily seen by the travelling public under unfavorable conditions. The guard-rail is the only warning a stranger using the road has of his approach to the culvert. The use of gas pipe for railings should be discouraged as much as possible, as it is difficult to see them, especially at night. Concrete spindle railings are strong, easily seen and when carefully built present a very attractive appearance. They must, of course, have well bonded and reinforced posts, top railing and curbs.

Municipalities which have not the necessary experience and facilities for constructing the above type, may use a solid reinforced concrete railing or they may advantageously use reinforced concrete posts with three or more iron pipe rails built into them.

In conclusion let me urge the desirability of putting a better finish on our bridges and culverts than has been the prevailing custom in too many of our local municipalities in the past. These structures, which in most cases are expected to last indefinitely, should have the appearance and substantiality which will conform to that of the magnificent system of roads which we may expect to have in the not distant future.

Discussion on "Culverts"

In the discussion which followed the reading of Mr. Sedgwick's paper, the importance of culverts was pointed out by Mr. Wheelock, of Peel County. He expressed the opinion that concrete tile culverts were failures, due, largely, to the lack of supervision in the manufacture of the tiles. His experience proved that concrete railings on culverts were much cheaper and greatly superior to pipe railings.

Further discussion followed, by several of the road superintendents and Mr. Hogarth, chief engineer of the Department, regarding measures for compacting the fill around culvert pipes and means of preventing the pipes from sagging. Mr. Hogarth directed attention to the fact that the cause of sagging of culvert pipes in the centre was a poor foundation. In many cases it was the practice to simply roll the pipe in the bed of a stream and cover it with a fill without making any attempt to remove the soft, oosy bottom of the stream. The weight on the pipe simply embedded it into this soft foundation. The proper method is to remove all yielding material from the bottom of the stream for a depth of 12 to 18 inches, and then replace with stone or gravel to insure a firm and unyielding foundation. The pipe could then be set without much fear of sagging.

Important Details in Oiling and Tarring

By W. Huber, A. M. Can. Soc. C. E.

Mr. W. Huber

It has been thoroughly demonstrated in recent years that roads carefully constructed of good crushed stone or gravel, on a well-graded, well-drained subgrade, and properly consolidated and bound, will not withstand the wear and tear of traffic as they formerly did. This fact is due not to any lowering of quality of material or standard of work, but to altered traffic conditions. The failure of ordinary stone and gravel roads under such new conditions has led many to believe that the usefulness of these materials for important rural road construction has ceased. Such is not the case, however. The failure has been traced to conditions in the road surface, not in the body. It has also been proved that, with comparatively inexpensive treatment and maintenance of the surface, a well-built stone or gravel road may be made capable of carrying any ordinary artffic without undue deterioration.

The need of some form of surface treatment to prevent dust on the more heavily travelled roads and to protect them from the effects of present-day traffic is now almost universally recognized, and the amount of protective work of this kind is increasing each year. The benefits of such work are twofold—first, in the prevention of excessive wear, and, second, in the increased comfort of those using the highway or living in its vicinity, through the elimination of dust, to say nothing of the prevention of damage to fruit and crops of all kinds growing near the road.

While in Ontario the treatment of roads with oil or tar has, up to the present, been restricted largely to city, town, and village streets, and to roads in the immediate vicinity of large centres, there is reason to believe that the majority of the most important rural roads will soon be treated in the same way. Owing to lack of experience on the part of those doing the work, results have in many cases not been satisfactory, and this fact is frequently construed as a reflection on the efficiency of surface treatment. While a lot of inferior material under the name of road oil has found its way on the roads, and proved not only unsatisfactory but also injurious, it must be remembered that the very best material may fail to serve its purpose if applied under unsuitable conditions or in an improper manner. Good results in the application of oils or refined tars will depend entirely on the care with which the materials are selected and the several operations carried out. Of no other branch of highway work can it be more truthfully said that the keynote of success is careful attention to every detail, or that failure to observe every one of the many important points may be followed by failure of the treatment.

The first important point in connection with the application of oil or tar to a road surface is the choice of material. Good intentions are frequently frustrated and excellent prospects spoiled by the selection of a bituminous material unsuited to the work. There are numerous different conditions under which bituminous materials are used, and there are several grades of material. Complete success depends on the selection of that grade of oil or tar which best suits the work in hand.

Light Oils Merely Dust Layers

The different materials used for prevention of dust and for the preservation of the road surface have been classified as non-asphaltic oils, asphaltic oils, and refined tars. If the material to be selected is expected to contribute in any degree to the binding of the road surface the choice will lie between the asphaltic oils and the refined tars. The non-asphaltic oils may serve the purpose of dust-layers, and if applied with sufficient frequency may do much to protect the surface, but their efforts are, at best, only temporary, and except for the protection which the road has received in the meantime, it is no better at the end of a period of treatment than at the beginning. Therefore, the non-asphaltic oils must be considered only as dust preventives.

On the other hand, the asphaltic oils—that is, those oils having as a base a certain amount of pure asphalt—are more than dust layers, and each application leaves, on the evaporation of its volatile constituents, a certain amount of asphalt in the road surface to act as an aid to the binder. The greater the asphalt content in the original oil, provided it has been properly applied, the greater will be the permanent benefit derived from its application.

As between the true asphaltic oils and the refined tars of corresponding grades there appears to be little choice, excellent results having been observed from the careful application of either material. Satisfactory results would, therefore, appear to be due not so much to the choice between oil or tar as to the selection of the most suitable grade and to the methods of application.

Thorough Cleaning Essential

Best results with any grade of material are obtained when the surface is absolutely clean and thoroughly bound. If the road surface does not comply with these requirements, the application of heavy oils or tars is not only a waste of money, but may result in actual damage to the road by hastening rutting and ravelling. It may be stated as an axiom that the cleaner and smoother and harder the road surface immediately prior to treatment the more complete will be the prevention of dust, the greater will be the protection to the surface, and the longer will be the life of the treatment. The less any material is required to act as a dust preventive the more it is enabled to act as a binder. If it is proposed to treat a road covered with dust, or only partially bound, then only a dust layer is required, and the use of a heavy oil or tar having other than dust-laying qualities is not justified.

Application of asphaltic oils or tars in any but the warmest weather is not recommended, but should it be found necessary to treat a road in the early spring or late fall, when the body of the road is comparatively cold, only the lighter grades should be used.

Having decided on the grade of oil or tar best suited to existing conditions, the next important step is the selection of a suitable day for the application. The warmer the weather the greater will be the penetration of the bitumen into the stone and the more satisfactory and permanent will be the result. The actual application should be made during the warmest part of the day, when the road itself has become heated. The longer the oil or tar can be kept in the liquid state the better grip it will have on the road, and the less danger of subsequent peeling off.

Casual Sweeping Not Sufficient

The first operation in the surface treatment of roads is the removal of all dust and foreign matter from the surface. Casual sweeping is not sufficient. The road must be swept till no dust remains and the bare stone shows over the entire surface. A horse-drawn rotary sweeper, which may be purchased for about $400, will give best results at least cost. Whatever the means employed for cleaning the surface, it must be emphasized that dust between the body of the road and the oil or tar is decidedly objectionable, and must not be permitted.

The lightest oils may be applied with an ordinary sprinkling wagon, but best results follow the use of a pressure distributor. Being discharged under pressure, the oil strikes the road with a considerable velocity, which causes it to spread more thinly and evenly, and assists penetration. For the heavier materials the pressure distributor must be used.

Excess Oil Detrimental

The quantity in which the oil or tar is to be applied is one of the most important details in surface treatment. The exact quantity measured in gallons per square yard cannot be stated, as this will depend on a number of factors, principal of which are the grade and fluidity of the material used and the condition of the road surface. Sufficient should be applied to cover the entire surface, leaving no bare spots, but positively no more. Any in excess of the quantity mentioned will be more detrimental than beneficial, in addition to causing a direct waste of money. The lighter, and consequently the more fluid, the oil the thinner it can be applied and still cover the road. For the same grade of material the consumption will be proportional to the area covered. Therefore, a smooth road, presenting less surface area than a rough one, will require less to cover it. A smooth surface also offers a better opportunity for even distribution and more uniform wear. An excess of material, particularly of the heavier grades, will run to the sides and cause lumps. Hot weather, assisted by the crown of the road, will eventually bring all excess to the edge in thick, uneven lumps and waves, which make travel on the sides of the stone very uncomfortable. Therefore, for the sake of appearance, of economy, and of comfort, the application should be carefully watched to see that absolutely no more oil is applied than is necessary.

Proper Temperature Is Important

Another important point is the temperature to which the oil or tar is heated. Some of the lighter oils may be applied in hot weather without heating, but better results have been obtained where even 40 per cent. oil has been heated, the principal advantage being better penetration. No definite temperature can be specified since different materials and different grades of the same material require different temperatures for best results. The correct temperature for any given material may always be ascertained from the manufacturer, and this temperature should be strictly adhered to.

The oil or tar having been applied, it must be given a fair chance to obtain a grip on the road, for on the adhesion between the road and the new surface will depend the life of the treatment. If the application has been made on a warm day, on a properly-cleaned road, there will be no difficulty in obtaining a satisfactory penetration, and no danger of peeling or scaling. The surface should be left entirely undisturbed for half a day; twenty-four hours is better. Traffic must be kept off. This is imperative. Wheel tracks have frequently been seen on oiled or tarred roads shortly after treatment, due to the passage of vehicles over the surface before the oil or tar had properly penetrated, or before the sand or stone chips had been applied. If it impossible to keep traffic off the road during the entire operation, and for a reasonable time afterward, only half the width should be treated at one time, leaving the traffic free to use the other half.

Bituminous Materials Do Not Take Wear

After the oil or tar has been distributed over the road surface and allowed to penetrate to as great a degree as possible, it must be covered with some material which will take the wear of traffic. For it must ever be remembered that not one of these bituminous materials, from the lightest oil to the heaviest grade of tar or asphalt, whether in the body or on the surface of a road, is a wearing material; it is nothing more or less than a binder, whose sole purpose is to hold together the separate particles of some hard substance capable of taking the wear. In the case of surface treatment this wearing material usually consists of sand, fine gravel, or stone chips. The lighter the oil or tar the finer will be the covering material which will be most suitable. For a light asphaltic oil, say 40 to 50 per cent., fine sand will give a satisfactory surface; for a 60 per cent. oil or tar of the grade known as tarvia "B," coarser sand should be used. For 80 per cent. oil or tar of the grade known as tarvia "A," the material should be half-inch to three-quarter inch stone chips or pea gravel. The two requisite qualities in any grade of covering material are toughness and cleanliness, and a slight extra expense should not stand in the way of securing materials with these absolutely necessary qualities. The best fine material is a clean, sharp quartz sand, water-washed if possible. For the heavier applications, trap chips, free from dust and dirt, are undoubtedly best, and their use is justified even at twice the price of pea gravel. Since the wear comes on the stone and not on the tar or oil, and since a cubic yard of covering material will cover from 75 to 150 square yards of surface, the extra expense of securing the very best material, considering its superior merits, is negligible.

Rolling Increases Durability

Where the heavier materials, such as 80 per cent. asphaltic oil or tarvia "A" are used, and covered with pea gravel or stone chips, a light roller should be used to finish the work. The rolling forces the stone into the bitumen, reduces the voids in the stone, and increases the proportion of stone in the wearing surface. The carpet coat, as it stands when finished, constitutes a species of concrete in which the gravel or stone chips correspond to the coarse aggregate in ordinary concrete, and the tar or asphalt to the cement mortar. As in ordinary concrete, the smaller the voids in the coarse aggregate the more durable will be the concrete. The rolling reduces the voids in the stone, increasing the proportion of stone to bitumen, and a mixture is secured which is less susceptible to heat, and which has not the same tendency to run or bleed in hot weather, as is shown by a surface coat which does not contain sufficient stone. The success of the heavier carpet coats depends on the material remaining where it is placed, and this cannot be assured unless there is enough stone to prevent running and the consequent formation of waves and lumps. The rolling may be done immediately after the stone has been spread over the road, and should be repeated the following day when the road has become warm again. If "bleeding" occurs—that is, if the oil or tar comes through the surface either during rolling or subsequently—it is an indication that more stone is required to take up the excess of bitumen. Two or three trips with the roller is sufficient for this operation, and best results are obtained from rolling in warm weather and during the warm part of the day. A light tandem roller, if such can be obtained, will accomplish the work more quickly at less cost of operation.

The success of any surface treatment depends absolutely on the maintenance of an unbroken surface. Experience and observation have shown that where an oil or tar surface has worn off, leaving the bare stone exposed, the road disintegrates more rapidly than an untreated road, and a pit soon forms. These pits, in large numbers, soon make a rough road which is very uncomfortable to traffic. Constant care is the only safeguard against such a pitted surface, and to that end the road should be patrolled at short intervals and any bare spots, or spots which threaten to become bare, thoroughly cleaned and covered with the same materials as were originally used. If this precaution is observed, and if the road has been constructed on a well-drained subgrade and with sufficient body to support the weight of traffic passing over it, the body of the road should last indefinitely, requiring only periodic treatment to keep it in first-class condition.

Summing up, success in oiling and tarring roads will depend on many factors, principal of which are the original condition of the road, the care with which it is cleaned prior to treatment, the selection of the most suitable grade of material, the weather in which the work is done, the temperature to which the oil or tar is heated, the quantity in which it is applied, the protection from traffic, of the freshly-treated surface, the proper covering with suitable material to take the wear, and, finally, on the careful maintenance of the treated road.

Discussion

Mr. James, of the York County Highways Commission, gave it as his impression that forced spraying of the oil assisted in removing dust. Thorough cleaning is essential if success is to be attained in oiling and tarring, and he believed that the application of the oil by pressure succeeded in removing a great deal of the surface dust. It was impossible, of course, to completely remove the fine dirt.

Mr. Parker, of the department, outlined New York State's experience in pressure application of oil. Experiments in this state proved that the pressure assisted in removing the dust, but it must not be so great as to atomize the oil and cause it to rebound in a fine globular or spray state. The pressure must be just such as to cause the oil to strike the road surface in an unbroken stream.

Mr. James asked if the wood tank does not shrink with the oil, and if, on this account, it was not better to use steel tanks, to which Mr. Huber replied that steel was more expensive than wood, but would probably be superior.

Mr. Fair, of Frontenac County, asked if a macadam road could be made without getting pitted, and Mr. James replied that he had found that a very effective measure was the application of 25 per cent. asphaltic oil as soon as the road is completed. This prevents the binder surface from disintegrating. The following year a heavier oil, 65 to 70 per cent. asphalt, is applied, and in this way the road is reasonably protected against any very great degree of pitting.

Mr. Huber asked if the application of oil kept out the moisture necessary to a proper cementing of the materials in the road body, to which Mr. James replied that he had experienced some trouble if the road is constructed and oiled in very hot or dry weather. In such case the oil sealed the surface so as to prevent the penetration of the moisture required to produce cementing.

Maintaining Earth and Clay Roads

By A. A. Smith

Mr. A. A. Smith

Owing to the absence in many places of rock gravel or other hard and durable substances, with which to build good roads, and by the reason of the excessive cost of such roads, where suitable material is scarce, a large part of our public highways will of necessity remain earth and clay roads.

When one considers the number of miles of this kind of road, in any township or county in the province of Ontario and compares it with the number of miles of surfaced road, it can easily be seen that it will be many years before even one-half of them are properly surfaced with either gravel or stone. For this reason it appears most important that we should give every consideration and thought to the construction and maintenance of the common earth and clay roads.

Importance of Earth Road Problem

In our effort to construct a type of road that will carry the ever increasing motor traffic between cities we are apt to overlook this earth road problem, where large sums of money are being spent, more often with poor results, which if handled properly would result in better roads and more of them, for perhaps less cost.

Before spending too much time or money on the maintenance of a road, one should bear in mind that this earth road may be the foundation for a later improved one with a surface of gravel, stone, concrete or other hard material. It will therefore be good business to first of all be quite sure that there is no question whatever regarding the correct location.

The chief factors to bear in mind in this respect are easy grades, proper direction, good foundation and drainage. The common error in laying out a road, is made in the endeavor to secure the shortest route between two fixed points. For this purpose the road is often made to go over hills instead of around.

Many of our roads were originally laid out following along boundary lines of farms and concession lines, regardless of grades. Here they have been allowed to remain, where a large amount of energy and material have been wasted in trying to travel and haul loads over them and in endeavoring to improve their deplorable condition.

Factors Governing Location

In locating the route one must also bear in mind that the road for the present will be constructed out of the materials over which it passes, so it will be well to carefully study the nature of the soils and avoid, where possible, any swamps, or morasses, and soils adjacent to beds of streams, not only on account of the poor nature of the road-making qualities, but also on account of the difficulty of draining.

A road can never be kept hard and smooth if the water from the surrounding land drains on to it. This can often be avoided by taking a little longer route, on nearby higher ground at perhaps a little greater initial cost, but certainly at a much reduced expense for maintenance.

A road should be finally located so that when constructed, the length and grades will be so balanced that a minimum amount of effort will be required to go from one end to the other. After satisfying oneself that the location of the road cannot be improved upon, the next most important feature to study is drainage. Water is, without doubt, the most destructive agent to any class of road, but much more so to an earth road, which is more susceptible to the action of water, more easily dissolved and moved by it than any other surfaced road, so, for this reason, too much attention cannot be given to this problem. This is true in all climates, but more so in Canada, where heavy rains are prevalent during certain seasons of the year, and where the winter months are attended with such severe frost and snow falls.

Water must be kept away from the road and rain which falls on to it must be made to run off as rapidly as possible.

Road Drainage Methods

Drainage may be divided into two sections: (1) Subdrainage; (2) surface drainage. The former will undoubtedly be required when the road runs through wet lands, over clayey soils, or where springs exist in the soil under the road. Various forms of underdrains are laid, some of wood, and some of stone, but at the present time there is no question but that the best results are obtained by the use of tiles, either porous or glazed, the latter being preferred, even if the cost is a little more, on account of their greater resistance to frost action. These tiles should vary from 3 inches to 5 inches in diameter and placed from 2½ ft. to 3½ ft. below the road surface, or just below frost level; they can be placed at one side of the road, or both sides if necessary, except in places where it may be necessary to carry off water under the centre of the road, where springs or spongy places appear.

The pipes should have a fall of at least 2 inches to every 100 feet. Previous to laying the tiles the bottom of the trench should be brought to a true grade and carefully levelled, so as to avoid any humps in the pipe line. In laying the tile care must be taken to get the ends to fit closely to each other, and cover the joints with a strip of tarred paper. When filling in the trench tamp the first few inches of material that is being replaced, above and around the tile, so as to prevent any possible displacement. Some people recommend filling over the pipes with gravel or small stones, but this is only necessary in certain soils of a stiff clayey nature. The object of subdrainage is to keep the ground supporting the road dry by carrying off all ground water before it can penetrate the subgrade, also in the spring season, when the frost comes out of the ground, any water resulting from the thaw will be quickly drawn off. Roads which were at one time impassable for wheel traffic on account of their muddy surface, have, after being properly subdrained, become most satisfactory highways, during all seasons of the year.

Surface Drainage

Surface drainage should now be considered. By this we mean that the crown of the road must be made waterproof, or in such condition as to shed water easily to open side drains or gutters, which also must be made to carry away quickly any water to the nearest natural outlets.

In constructing an earth road the cross fall of the surface in level country must not be less than 1 inch in 12 inches. On hills the camber should be greater, say 1 inch in 9 inches, so that any water falling on the road will not be allowed to run down the wheel tracks lengthwise of the road, and thus create deep ruts.

In many parts of the country one will find V-shaped ditches constructed across the surface of the road; these are more often found in hilly or rolling districts, and are generally spaced about 100 feet and varying in depth from 6 inches to 12 inches. These drains are not only dangerous, but very uncomfortable to travel over, also hard on all vehicles, so should be avoided whenever possible. These can often be eliminated by giving a high crown to the road, good side ditches, and a good, smooth surface. Care must be taken to keep all side ditches in such condition that water will not be allowed to remain in them. They must be kept free from weeds and rubbish and have sufficient capacity and grade to carry quickly away the water reaching them under conditions of maximum flow.

Use the Log Drag

In order to ensure a good, smooth, dry surface to the road, one will not have much difficulty after the drainage has been properly carried out. This can be done most economically and successfully by the systematic use of the log drag. It is needless here to go fully into the construction or the use of the drag, as it would be old news to you. However, as this method is the most important in the maintenance of a clay road, it will perhaps not be out of place to impress on you a few of the most important points connected therewith.

First of all the drag should be made of light material, preferably cedar or pine, so that it can be easily drawn by one team of horses, and frequently. Remember that the drag is not blessed with brains, and if these are not possessed by the operator one can hardly expect good results. Remember also, that the road drag will not do the work of a grader.

Drag the surface of the road after each rain storm, not when the road is too soft, but while it is still moist. The man in charge will be the best judge as to the correct time to use it, on account of his previous experience of the different characters of the soil. The material moved by the drag, in planing off tops of ridges and rough places should be smeared in a thin, even coat over the surface, fill up hollows and ruts, and help to keep a good crown.

Do not attempt to move more earth than is absolutely necessary. The driver should ride, and by so doing he will be able, after a little practice, to manipulate the drag successfully by moving his position backwards or forwards.

A few hours of labor spent at the right time will often save serious destruction, which may take much time and money to repair.

Systematic Maintenance Necessary

All railway companies adopt a strict system of maintenance to take care of their roadbed, bridges, culverts, etc., and as they have proved it good business to them, it surely will apply to the same extent, or even more so, in highway work.

There are several methods of operation which could be adopted to advantage, one of which I might mention:—In case a township has not entered on a county road system, then the council should appoint a road superintendent, who must be an experienced and responsible man, who will take charge of, and be responsible for, the upkeep of all roads. His appointment must be permanent, the same as the township clerk and treasurer.

The roads in the township should be divided off into sections of three to five miles, and a man should be engaged for the season to take care of each of these sections. Often farmers, or people residing along the road, will be willing to undertake this work. It will not take up the whole of a man's time, and the most efficient work on an earth road should be done just after a rainfall, which is usually a time when the farmer is less able to work to advantage on his farm, and when he can often more easily spare a team which could operate the log drag, or do any necessary grading required.

These section men should be provided with rakes, shovels, axes, picks, wheelbarrows, bush scythes, tool box, and last, but not least, a road drag.

Duties of Section Men

The duties of the men will be to restore the proper shape over the grade, give the surface a good floating, so as to keep it smooth, and not allow any ruts or rough places to form. This can better be accomplished by the drag, after every rainfall, and when the dirt is about the consistency of putty. Besides this, he must fill up all holes with the same kind of material as the existing road surface, and not on any account with gravel or stone. The men will be expected to put in one or two days each month on the repairs to culverts, bridges, ditches and underdrainage. They must also keep down the brush and weeds, trim all trees, break through the snow in winter, erect snow fences, and in general keep the road up to the required standard of the road superintendent and to his entire satisfaction.

It will be difficult to arrange a detailed set of requirements necessary for the maintenance and suitable for every section, as each one may be varied considerably by local conditions.

The road superintendent will have sole control of the section men with regard to road work. He will be expected to visit and inspect their districts periodically and thoroughly study conditions together, so that he will be in a position to advise and guide the council from time to time.

If an inexperienced man is engaged as superintendent, too much must not be expected from him for the first year, but, as in all businesses, success is largely dependent on the choice of a capable man in charge.

Superintendent Should Have Full Authority

In placing responsibility on him he must be given full authority with regard to hiring or discharging men and teams; he must advise the council; the council will decide the work to be done, but the doing of the work will be entirely in his hands.

If statute labor is retained in the township the pathmasters will take the place of the section man previously mentioned.

The road superintendent should acquaint himself with the best methods of constructing and maintaining all classes of road and should know how to operate all graders, crushers, rollers and all other road-building machinery so that if at any time he is called upon to improve the earth or clay road surface he will be in a position to undertake the work.

He shall be required to keep an accurate record of all the men employed and work done, so as to be able to furnish the council whenever required with pay-sheets, accounts, and vouchers, and be in such a position as to be able to show in detail the character, location and cost of each separate piece of work undertaken, whether for grading, ditching, tiling, dragging, culverts, or other work connected with the care of a road.

Discussion on "Maintaining Earth and Clay Roads"

The maintenance of earth and clay roads was all-important, according to the Deputy Minister, Mr. McLean, inasmuch as this type of road formed the greater part of Ontario's highway system. He preferred the grading machines to the log drags, although the latter were of the greatest benefit in keeping an earth or clay road in shape. In using the log drag, the condition of the road had much to do with the result. If the roads were too wet or too dry, good results could hardly be expected, but his investigations seemed to indicate that the log drag proved most efficacious if the road were dragged during a rain or immediately after, when the surface was covered with a kind of grouty or putty-like crust.

Mr. Mullen, of Essex County, said that the drag was a very common implement in his county, since the roads down his way were largely of clay.

A new and very useful device was described by Mr. Wheelock, of Peel County. This was a home-made concrete roller to roll the centre comb, that resulted from the use of the split log drag on earth or clay roads. A roller of this kind, made in the steel shell of an ordinary steel roller, would cost from $30 to $35 and was very effectual in removing this comb, which was always a difficult proposition. The advantage of this type of roller is that it can be used when and where a steam roller is impossible. Mr. Wheelock did not particularly advise the use of the drag on gravel roads. In some cases it draws the stone which ought to be kept embedded in the surface to carry the load of traffic.

Road Foundations and Drains

By R. Crawford Muir, A.M. Inst. C.E., A.M. Can. Soc. C.E.

Mr. R. Muir

THE first problem in road construction is the location and gradient, but in connection with the travelled surface the chief factors are the drainage and the foundation. Drainage is so closely allied to foundations that it is difficult to speak of one without taking the other into consideration. Too much cannot be said of the importance of drainage. It is important in connection with any class of road construction.

The drainage of roadways is of two kinds, viz.:—surface and subsurface. The first provides for the speedy removal of all water falling on the surface of the road; the second provides for the removal of the underground water found in the body of the road, a thorough removal of which is of the utmost importance and essential to the life of the road surfacing.

Underdrainage

Subsurface, or underdrainage, is not always required, but in seepy ground is a necessity; with a subsoil of a sandy or gravelly nature underdrainage is not required. On the other hand, a clay soil which readily retains water will become almost impassable unless properly drained. In low places where the water settles at the side of the road, keeping the subsoil constantly saturated, subdrains will effect a marked improvement. Springs on hillsides, unless led from the road by drains, will soften the soil with a consequent failure of the surface at these points. Quicksands have absolutely no supporting power, but if properly underdrained they may serve as a suitable foundation.

A road cannot be maintained in wet ground. Sometimes blind drains will carry off the water. At other times it may be necessary to lay longitudinal or transverse tile drains. Blind drains are not as efficient as tiling on account of their liability to become partially clogged by silt.

Side ditches, if properly constructed, often will drain a damp roadbed. These ditches play an important part and must be looked after at all times. Even when underdrainage is not needed, good side ditches are always required. Ordinarily they need not be deep; but, if possible, should have a broad, flaring side toward the roadway. The outside bank should be flat enough to prevent slipping. When the road is in an excavation, ditches should be provided so as to prevent the water from running down the centre of the road; the steepest grades need the ditches most. Where grades exceed four per cent. and the soil is loose and sandy, the ditch should be paved with cobblestones or field stone in order to protect the shoulders from wash. These gutters can also be used to advantage at intersecting roads where there is not sufficient headroom for a culvert.

Proper Drainage Most Important

As a rule, the ditches, culverts, and the roadside in particular, along our highways do not receive the attention they deserve. Often we find weeds and brush growing along our main roads, blocking the flow of water and preventing it from escaping quickly to the outlets, and besides, their existence is not pleasing to the eye. It is not a rare occurrence to see culverts almost wholly blocked with weeds and silt, thus causing unnecessary flooding and damage. It is admitted on all sides that drainage is of the utmost importance to all roads; such being the case, it behoves us to see that everything is done to keep the highway in as perfect a condition as possible.

In providing for cross drainage only permanent material should be used, for the failure of a cross culvert will not only block the drainage, but will damage the road surface and may cause accidents. Cross culverts are required to distribute the water to natural channels so that the side ditches do not carry too much water. While the cost of carrying water away from the side ditches often seems prohibitive, the expense is always warranted by the better construction obtained. When impossible to provide complete drainage the elevation of the subgrade should be at least two feet above high water level.

The main object in underdrainage is to lower the water level in the soil; in other words, to intercept the ground water before it reaches and softens the subgrade.

Tile Drains

In many cases a line of tile on one side of the road will be sufficient. In these cases the tile should be placed on the high side of the road, preferably under the ditch where the greatest depth can be obtained with the least excavation, and where the water is caught as it flows out of the hill. Sometimes a section of a road is wet because of a spring, or perhaps the road is muddy because of a stratum which brings the water to the road from higher ground; in either case, the source of supply should be tapped with a line of tile instead of trying to improve the road by piling up earth.

All drains should be carried to a proper outlet, either to a culvert, to another drain, or through a bank. When the drain is carried through a bank the outlet end should be protected by a masonry or concrete wall which extends back along the pipe for a distance of three feet, thus preventing the water from undermining the pipe at this point.

There are places along a road where the water may be turned off at either side, such places, for instance, as a fill with the ground sloping away from the road on both sides. If there is much water to be turned over the bank it will be necessary to protect the bank from washing out. A small amount of water running down high banks composed of sandy soil is liable to cause great damage, for the small gullies made by the water may rapidly extend back into the road surface. The bank should be protected by sod, or a paved channel should be constructed down the side of the bank to carry the water. In soils where there might be some question as to the advisability of using a gutter, a vitrified pipe or a wooden trough may be constructed down the side of the bank.

In planning the drainage for a road improvement, it is well to make as few changes as possible from the existing scheme.

After drainage is secured, the important points in road foundations are the removal of all vegetable matter and the building of a uniform foundation. Dragging and planing the subgrade as it is being built will prevent the waviness of surface which develops occasionally after the completion of a road.

Foundations

The subject of foundations will be considered under two heads, viz.:—Natural foundations and artificial foundations.

With the exception of earth roads, the construction of all of the more common types of roads might be described as three distinct steps, viz.:—the construction of the subgrade or natural foundation, the construction of an artificial foundation, and the construction of the wearing surface. Therefore, the lower courses of either a macadam or a gravel road might be considered as types of artificial foundations.

Any subsoil will generally be improved by rolling and such a process will show up weak spots that should be replaced with other material. As a rule, the subgrade does not receive the attention it should in construction. It cannot be too carefully prepared. It should be thoroughly drained and compacted, soft material removed and fills allowed to settle before the foundation, which is to carry the wearing surface, is laid. It is the subgrade that carries the load and resists the blows of heavy traffic. The real foundation of a road is the earth subgrade, and it develops its greatest bearing power when dry.

A natural foundation is one where the surfacing material is laid directly upon the subgrade. Gravel or a sandy loam when properly prepared makes a suitable foundation for macadam or concrete.

Before concrete is laid as a surfacing or a foundation on an earth surface, a layer of cinders, gravel or crushed stone as a cushion should be spread to keep the moisture away from the base of the surfacing. This construction would lessen the number of cracks in the concrete surface. When gravel is used as a subbase for concrete surfacing it should be absolutely free from clay or loam, and rather sandy.

Foundations for Gravel Roads

Surfacing with gravel constitutes a large portion of rural road work and a great deal of money is wasted in not properly preparing the foundation for this surfacing. Common practice is to place gravel to a depth of from 6 to 8 inches on clay soil, frequently on a newly shaped roadbed. Until compacted the coat of gravel serves as a sponge, holding the water until the subgrade is softened, thereby allowing the material to be cut through and much gravel lost, with a consequent rutted and uneven condition of the surface.

Foundations for gravelling should be firm and hard, and on new work this may be accomplished by forming a crust with a mixture of 2 or 3 inches of sand and gravel with clay subsoil, rolled to a smooth surface, on a sand subsoil it is equally necessary to have a foundation to prevent loss of gravel, and in such cases clay mixture is required.

Most gravel contains a proportion of silt or loam sufficient to draw moisture so that the frost will work into it and, of course, when the frost thaws, it leaves the material porous, spongy and wet. This condition is made worse by the traffic, which tends to puddle the surface, drawing the moisture from below. Such a result may not be serious if the road is of gravel or waterbound macadam, for such can be easily and cheaply repaired, but if the surface is bituminous it may be ruined. It should be borne in mind that a road may stand up two or three years over a poor subbase with little apparent trouble, but go to pieces the third or fourth year. This fact has caused a great deal of trouble, for the inexperienced man, finding that a road stands all right the first year assumes it will continue to do so, and proceeds with the same type of construction under similar conditions until the first fails and the whole road is ruined.

Artificial Foundations

Among the artificial foundations which are suitable to meet the traffic requirements, are concrete, surfacing to meet the traffic requirements, are concrete, rubble, telford, broken stone or gravel. The character of the foundation to use depends on the volume of traffic; the type of surfacing to be placed thereon and the natural soil conditions.

A gravel foundation should be thicker than a crushed stone foundation, as the fragments do not interlock as firmly as crushed stone. The choice between a gravel or a crushed stone foundation rests entirely on the relative cost.

When crushed stone is used as a foundation the size of stone should be 2¾ to 3¾ inches, but where local stone is used the size may be from one to 3¾ inches, in order to take up the total output of the crusher. Crushed stone must never be laid on a soft subgrade. The distributing power of this course depends largely on the stone fragments being firmly interlocked; if the stone is placed on a soft subgrade and rolled, the earth will squeeze up between the fragments and separate them. The course should be rolled until no movement is under the roller.

One of McAdam's theories was that no stone larger than two inches should be used in a road. But experience has shown that this size of stone is unsatisfactory for foundations and is only suitable for surfacing. With crushed stone the units are so small they have little bearing, and as they have no cohesion when wet, sink readily. It should also be borne in mind that the cost of crushed stone is greater than the larger size stone.

The V-drain Foundation

A type of foundation used to a great extent in the United States is the V-drain. A V-drain, so called because it is really the shape of a flattened "V," is constructed by excavating the roadway for its full width, from 4 to 8 inches deep at the sides and from 12 to 18 inches deep at the centre. This excavation is filled with stones not over 8 inches in size. The larger stones are placed at the bottom of the trench and the smaller stones at the top. This V-drain is a combination of foundation and drain, the water flows in a channel in the centre of the road, whence it is led off by bleeders to proper outlets. A V-drain should only be used where the road lies over a wet or heavy soil.

The objection to the V-drains is that owing to the extra depth of stone in the centre of the road, the frost action is not as great at that point as at the edges, where the stone is lighter, and a considerable distortion is occasioned in the road surface when frost sets in.

Field stone or flat rubble stone are sometimes substituted for the V-drain foundation. When flat stones are used, they are laid on the subgrade on their broadest face and small stones thrown on the surface to fill the crevices, and the whole is rolled until hard and firm. This type of foundation has given satisfactory results and is much cheaper than the Telford foundation. If a bituminous surface is to be placed on this foundation, a layer of clean sand should be spread over the surface of the foundation, so as to fill the voids; this is rolled without wetting and any surplus material swept off. The sand is only used to prevent loss of bituminous material, and is not an essential part of the foundation. Bleeders are used, where necessary, to drain the water from the foundation.

The Telford Foundation

The Telford foundation as a base for macadam surfacing is well known. Properly laid, the supporting value and stability of such a foundation is high and in many cases its use has been economical. On the other hand the development of traffic conditions has resulted in such severe strains on these foundations that they have failed. Probably most of the failures are due to unevenness of surface obtained, and a consequent lack of uniformity in the thickness of the surfacing. A Telford foundation which has been used as a base for a water-bound macadam surface, from which the macadam has been worn off makes almost an ideal foundation, when brought to a true surface, upon which to lay a bituminous surface; provided that the stones have been originally set on a proper subgrade.

When roads are constructed with a view to utilizing in the future such construction as a foundation for some form of surfacing, the Telford method of construction is one that should be considered. The quality of the material, used as a foundation, need not be as good as that on the surface, since it will not be subjected to the wear of the traffic. Artificial foundations constructed with stone aid the drainage, besides directly improving the bearing power of the soil.

Concrete Foundation

Concrete, apparently the highest type of artificial foundation, has become an approved foundation for any block or asphaltic concrete pavement, and is used chiefly on city streets. The necessity of using a cushion on the concrete foundation is a matter about which opinions differ.

The foundations for higher types of road surfacing, such as bituminous and concrete, require perhaps even more attention than for gravel or macadam roads. The material must not only be firm, with adequate provision for drainage, but the sub-grade must be thoroughly drained out before the surfacing is placed. Most of the cracking and failure of concrete roads has been due to moisture in the sub-grade at the time frost sets in.

Foundation for Macadam Road

An economical design of foundation for macadam roads may be summarized as follows:

For moderate traffic use pit run gravel, local gravel if available, varying the depth to suit the soil. If gravel is not available, use crushed stone for ordinary soils and field stone for bad foundations. The economy in the design of macadam roads is greatly increased by utilizing local material, preferably uncrushed, to its fullest extent. If the supply of local material is limited it should be used for as much of the road as possible, and advantage should be taken of the different local supplies by changing the design to allow their use with short hauls.

In planning the construction of a new road it is wise to go over the road in the spring, when the frost is coming out and notice the bad spots, the spots that heave, and then when you build your road you can take these spots and provide some method for taking care of the ground water. If not, then in the summer the road is as hard as any other part.

The stability, permanence, and the maintenance of any road depends upon its foundation. If the foundation is weak, the surface will quickly settle unequally, forming depressions and ruts.

Essentials of a Good Foundation

The essentials necessary to the forming of a good foundation are:—

(1) The drainage of the subsoil wherever necessary.
(2) The entire removal of all vegetable matter.
(3) The thorough compacting of the natural soil by rolling.

(4) The placing on the natural soil so compacted of a sufficient thickness of an impervious material, which will effectually cut off all communication between the soil and the bottom of the surfacing.

Increasing the Safety of Our Highways

By W. H. Losee, B. Sc.

Mr. W. H. Losee

Owing to the growing volume of traffic on our highways and the increasing speed of vehicles the roads that were once built for the slow moving horse traffic are not now adequate for the fast moving motor traffic. Not only is the character of the road surface itself not adequate but the alignment and grades are receiving more attention now than they did twenty years ago. Because we are still using the roads with steep grades, crooked alignment, and in some places narrow roadbed, many accidents occur where a few years ago an accident of the same nature was unheard of, and we must begin to correct these defects or accidents will increase as steadily as the use of the motor vehicle is increasing.

Besides the accidents that occur from the above causes, the most serious and common kind are those which happen at level railway crossings, and their prevention is becoming a very important matter.

Since the motor vehicle has become so universally used the tendency has been for the city dweller to live somewhere in the suburbs and go back and forth to his office in his car. This has increased the traffic on streets that the railways are bound to cross and automatically increases the dangers of level crossings. Motor traffic in the suburban areas is very heavy between the hours of 7.30 and 9 a.m., and 5 and 6.30 p.m.

On the other hand, the man who lived in the country a few years ago, used only the roads that took him to his post office, to church, and to his market place and shipping point. Ten miles was an average radius for any farmer and he generally knew the dangerous crossings, and about the time any fast train would be crossing them; the result being that there were very few accidents.

But the motor vehicle has changed these conditions entirely. Motorists are continually going into new country, railway crossings are encountered everywhere, and sometimes when they are least expected. Generally a car carries from four to five people who must depend upon the judgment of the man at the wheel. He cannot therefore afford to be careless, because any accident is bound to injure more people than the driver, and it does not seem fair that people should be exposed to danger by a man who tries to be too "smart" or careless. Crossings should therefore be made as nearly as possible "fool proof."

There are many different methods of protecting a railway crossing. There is the overhead crossing, the subway, the gates, the watchman, the electric bell, and the "danger" sign post.

The Subway Crossing

Let us first consider the subway. This measure of protection is undoubtedly the best one of all, but the cost of its construction, except in thickly settled districts, almost makes it prohibitive. It may cost anywhere from thirty thousand to one hundred and fifty thousand dollars to construct one subway, and as the crossings in Ontario are many, any undertaking to separate all crossings would bankrupt the province.

There are subways already built in Ontario that are so constructed that they are now a menace to the travelling public. The centre line of the subway was generally built at right angles to the line of the railway instead of being parallel with the centre line of the highway. The result is a bad turn at the entrance and exit of the subway and the view along the highway is so obstructed as to make a serious accident possible.

This trouble can now be largely done away with as the plans for each proposed subway must be submitted to the Dominion Railway Board or the Ontario Railway & Municipal Board, by whom local conditions are thoroughly investigated.

Gates and Watchmen

The next best way of protecting a crossing is by means of gates. These can be operated at about $800 per year, and have been in use for many years, but they are defective because people often run under them and the bars have been broken many times by vehicles running into them.

Watchmen have also been used for a long time as a means of protection to the public at crossings, but should a crowd or a reckless motor driver or an unruly horse wish to cross the tracks, he is powerless to prevent them. The watchman is as a rule never dressed any differently from the ordinary person, and there are times when it is difficult to distinguish him. A great help in this regard would be to dress him in some kind of distinctive clothes and have a uniform standard of signals that everyone would understand, and if it be found possible, give him the power of a constable, so that he could arrest anyone who disobeyed him or the law.

Bells and Danger Signs

The electric bell is used to a great extent on country railway crossings, and it has proven to be a very good warning signal. They, however, have been known to get out of order and ring for days before they are repaired, the result being that travellers would come up to the crossing, wait for a while and then, when no train would come, cross over. Anyone fooled that way is naturally apt to disregard them entirely.

Lastly, we have the sign of "danger." These are placed by all railways on the right-of-way at the crossing. If a driver should come around a corner or any obstruction that would be near the crossing suddenly, he may be too close to stop and the sign at the crossing is naturally of little use. It would be much better if all danger signs were placed about 400 feet from the crossing and were so placed that they would be readily seen. They should be painted white so that they have the best chance of being seen at night.

The manner in which subdivisions have been laid out in parcels of land that are cut by a railroad has been the cause of much expense to railways and municipalities when these lands are built upon. Surveyors paid little attention to the number of crossings that would be necessary in the event of the growth of the town. According to their surveys a crossing is necessary where each street on the plan crosses the tracks, but had they allowed for a narrow street paralleling the railway on each side of the track, subways would be built or gates put up at proper intervals so that there would be the minimum number of crossings to serve the maximum number of people. This gives the driver of the engine a chance; he can be more careful at the crossings and still make better time. The number of subways, gates or watchmen would be reduced and likewise the cost of maintaining them would be lowered. The Dominion Railway Act requires that all approaches to railway crossings should not have a greater grade than five per cent. It is because of steep approaches that a car sometimes stalls on the crossings and makes an accident possible.

There is little doubt that carelessness on the part of pedestrians and drivers of vehicles is the great cause for many accidents, and if people can be taught to be careful, the number of accidents will be considerably reduced. The Ontario Safety League, and the Ontario Motor League, with the aid of the government and the railways, are doing a great work along the line of educating people to be careful, and we can all do missionary work along these lines. The phrases "Safety First," and "Stop, Look and Listen," are commonly used now. But how many people heed the latter phrase at a railway crossing? Very few people stop and look, some slow up and look, some just look one way and others never slow up or look at all; they simply take a chance.

Data on Grade Crossing Accidents

In an article entitled: "Accidents at Grade Crossings," written by Mr. Alex. Gordon, a commissioner of the State Railroad Commission of California, there are some very interesting facts with regard to the carelessness of the travelling public. He says that: "The Southern Pacific Railway Company recently made test observations at thirty-four crossings. They observed over 17,000 motor vehicle drivers and found that 69.5 per cent. looked neither way before crossing the tracks, 2.7 per cent. looked in one direction only and but 27.8 per cent. looked both ways; 9.3 per cent., or the incredible number of 3,300 drivers, ran over crossings at a reckless rate of speed. Only 35 drivers, or two-tenths of one per cent., stopped their machines before crossing the tracks.

4,900 drivers of teams were observed, 39.4 per cent. of whom looked in neither direction, 8.6 per cent. looked one way only, and 52 per cent. looked in both directions. Of 6,300 pedestrians observed, 49.1 per cent., or practically one-half of the total, looked neither way; 15 per cent. looked in one direction only, and 35.9 per cent. looked both up and down the track. The same company has tabulated the accidents on grade crossings which have happened during the last five and one-half years in an attempt to secure the reasons for these accidents, with the following results:

	Killed Per cent.	Injured Per cent.
Ignored train and its warning	35.0	37.1
Ignored train and its warning and warning of crossing bell, automatic and human flagman, and warnings of other persons	13.8	12.6
Ran into side of train	10.1	15.3
Stalled on track	7.8	4.2
Tried to beat train to crossing	16.0	9.3
Other causes	17.3	21.5
	100.00	100.00

This company, during two years, had 525 crossing gates broken by vehicles which drove into them when they were down.

In the United States during the year ending June 30th, 1916, there were 1,310 people killed and 3,184 injured on highway grade crossings of railways.

On the Central Railway of Georgia, 78,275 drivers of motor cars, motor cycles and horse drawn vehicles were observed at railway crossings, and of these 59,700 did not look in either way before starting across the railway, or in other words, about 75 per cent. took no precautions whatever, even though they were approaching the danger zone of the railway.

Warnings Disregarded

Nor do accidents always occur at dangerous crossings. At Thamesville, Ontario, last year, at the Grand Trunk Railway crossing, three people who were driving in an automobile were killed. The crossing was equipped with an electric bell, there was a red warning light designed to show the approach of a train, and fifty feet from the crossing there was a clear view of the track for two miles.

In order to make people more careful a law in Paris, France, was enacted which made it possible to arrest any pedestrian who was hit by a moving vehicle between street intersections. This resulted in the reduction of accidents by fifty per cent. On the other hand, any driver who was found guilty of breaking the traffic regulations had his license cancelled. The people soon learned that the proper place to cross a street was at an intersection where the vehicular and foot traffic was regulated by a police officer.

As was mentioned at the beginning of this paper, there are many other features of our highways that take their toll in accidents. The narrow road with the high crown that compels motorists to stick right on the top and makes the man with the horse move well off or lose control of him, has caused more than one casualty. Besides the harm done to the road by continuous travelling in the same rut, the road with too steep a crown is dangerous. If it happens to be wet and slippery the motorist, believing that it might be difficult to get back on the road, or fearing he would slide into the ditch, does not care to turn out. If it is a man with a load of hay there is a possibility of it overturning when he pulls out on the steep side.

The width of road is pretty well governed by the traffic it has to withstand. It should have a crown that would shed the water, and yet be wide enough so that traffic would be diffused over the whole surface. It should always be borne in mind when contemplating construction, that immediately a road is built traffic will increase, and the type of road should be designed with this increase of traffic in view.

The steep, narrow road on a hill with a sharp turn at the bottom, is another source of danger, and makes many anxious moments for the driver of a heavy load or a motor vehicle. Sometimes the brake refuses to set and he is going so fast that he cannot make the turn at the bottom, and plunges headlong through the flimsy railing, causing destruction to the car and certainly injury to its occupants. A dangerous condition like this can generally be averted by a change in the location of the approach to the bridge or of the bridge site itself; perhaps a longer, easier grade could be found, or by raising the bridge the approach to it could be rendered less liable to cause a serious accident.

Owing to the nature of our early surveys there are many jogs and sharp turns on our roads. In one county there are turns greater than 90 degrees. It has caused this county no small amount to make these turns safe and still keep within the road allowance. This was done by raising the outside of the road by the addition of more stone, which enables the driver of a car to make the turn without a chance of an accident. An improvement on this is to lengthen the curve by using a piece of land adjoining.

The grade of the steep hills could be reduced and the sharp turns eased if the owner of the adjoining land could be brought to see the great benefit he would confer on the travelling public, and the words of commendation he would bring from everyone if he would consent to sell it at a reasonable figure.

All narrow fills, approaches to bridges and deep ditches, should be protected by a good strong guard rail. The deep ditches in the clay sections of Essex and Kent counties are very dangerous. When the clay road surface is wet it becomes so slippery that to turn out in some of the narrow places is a very hazardous undertaking. These roads should be surfaced with any material that would reduce the slipperiness, and a guard rail should be built at the edge of the ditch. Many of the ditches were dug years ago when the traffic was not as it is at present. They were put within the road allowance when they should have been dug in the adjoining field. From now on it is going to cost something to render them safe.

Warning notices of steep hills, sharp turns, and railway crossings should be erected at proper distances from them. It would be advisable to have these signs standard in form and placed in the most conspicuous position.

The Ontario Motor League have done something in this regard, but their signs are often stuck up on telegraph posts, and in places where they are not always readily seen. Those signs are a great help on the main travelled roads, but the motor car is now found in the most remote districts, and it is there where the dangerous roads are, and where signs denoting danger are badly needed.

Another matter that is giving some concern to the county road superintendents and motorists is the erection of rural mail box posts too near to the travelled road. It makes it difficult to grade properly and they are sometimes so close to the road as to be a menace to the safety of the travelling public.

In conclusion we should all remember that carelessness is the cause of a great percentage of accidents. Education along these lines, although seemingly slow, is achieving results; and everyone present should bear in mind that "an ounce of prevention is worth a pound of cure," and we should do all in our power to reduce the number of accidents that are taking the lives of our citizens, when human lives have more value to the country than they ever had before.

Repairing Gravel and Stone Roads

By R. M. Smith, B. Sc.

Mr. R. M. Smith

THE subject "Repairing Gravel and Stone Roads" has been considered in a clear and fairly broad manner at many conferences previous to this. The writer simply desires to introduce the subject again that discussion may follow and new and interesting points may be brought forward by the road superintendents and engineers present.

We have all classes of roads, and, as many as they are, they all need repair. The concrete, the asphalt, the brick, the wood block, have become fairly well standardized in their method, most municipalities operating along same lines. Why, we ask, cannot the repairing of stone and gravel roads become just as consistent? Is it because of the ever-changing conditions or is it a simple case of neglect on our part? Two years ago an article read at the first conference discussed at some length a method of caulking horses' shoes that the road might not be torn up. At the present time we have almost forgotten the horse-drawn vehicle, and on every hand you hear the words "automobile traffic." The cities have constructed roads to meet this traffic, but the cost of these would be prohibitive in the country, so what is the next best thing? Many miles of macadam and gravel roads have been constructed throughout the province, and now that they are constructed, how shall we keep them in repair under these above-mentioned automobile traffic conditions?

Constant Attention Essential

There are two things which should be remembered: First, roads deteriorate rapidly if neglected, frost, heat, water, drought, and traffic tending to flatten the surface and mix it up so badly that it is pounded into the subgrade; second, the macadam or gravel road constructed at the present time will not stand up under the increasing traffic without attention.

Construction or resurfacing a macadam or gravel road must never be undertaken until ditches are provided and culverts have the proper outlet. To get the water away from the road should be the first consideration; too often this, the most important item in resurfacing or construction, is neglected. The idea seems to be to place the stone on the road as fast as possible, round it into shape regardless of mud holes, soft spots, and drainage, letting the water take care of itself. It is not the intention of this paper to go into the method of construction or drainage, however, but certainly the method of construction has all to do with the method and cost of repair. Often we see gravel being dumped into a mud hole on a clay road or a soft spot in a gravel road being filled with something else. Sometimes we see bituminous patches on a macadam road which apparently have no oil elsewhere, mixing materials in this way either causing bumps or hollows. Repair a clay road with clay, a broken stone with stone, and a gravel with gravel.

Macadam Road

Repairing a macadam road should be started as soon as the road is constructed. It is practically impossible to construct a water-bound macadam that, under the traffic of to-day, will not rut. Automobiles are like sheep—if one starts a rut, the next one follows. The first rain fills the rut with water, and the trouble begins. "Allow no ruts to form" should be the motto of road superintendents. Keep the surface round and smooth. This enables the water to get more quickly to the ditch and eliminates bumps and holes that would form otherwise. Broken stone, the same size as used in the upper course, should be used for filling ruts. It must be tamped to place, the finished surface a trifle higher than the surrounding surface, to allow for consolidation by traffic. Pot-holes are repaired in Europe by the removal of material to depth of wearing course, stone then replaced, tamped to grade, with stone chips as top dressing. Bituminous material may be added, either before or after placing. Rolling in spring, when road is soft, has also brought good results. The earth shoulders should be trimmed up from time to time with road scraper, that water may run freely to the ditch. Continuous repair is the only way to increase the life of the road. Too often roads are constructed and are left to themselves from two to three years—sometimes a considerable time longer—without the slightest attention.

Systematic Repair Work Required

The next question that rises is, who is to make the repairs? We must provide systematic methods of repair and maintenance. Too little attention has been given to this end of the work. How often we drive on the country road directly after it has been constructed and see signs of ravelling and rutting that with a few minutes' attention could be made as solid as surrounding surface!

The continuous patrol system that has been advocated by engineers both in Canada and the United States has either not found favor in Ontario or else we have neglected to carry the idea far enough. The railroads have their sectionmen, who keep the track and surface in repair. Why cannot the same system be applied to our public roads? Until such a system is inaugurated we will have the same high cost of resurfacing every few years.

Resurfacing Methods

The time must come, however, when patch work and the best system of patrol will not suffice to keep the surface in shape; then it must be resurfaced. Where the road is full of pot-holes, the scarifier, or picks bolted to rear wheels of roller, can be used to advantage. The scarifier brings the stone to the surface, making a better bond for the new material when placed upon the road. The surface is then watered and consolidated with the roller. Where in the original construction the stone was of a considerable depth, this method of resurfacing may be sufficient for a year or so. However, if in the original construction the surface was thin, new material must be added. It is advocated by many engineers that where more than three inches of material is being placed on the old surface it should not be disturbed, but new material applied, watered and rolled, just as in new construction. On a considerable mileage of our country roads we have gone a step further than this, and added a bituminous material in our resurfacing. This has several important advantages. It makes a surface that is impervious to water, has better wearing qualities, is dustless, and eliminates the high crown we dread so much in new construction, one-half inch to the foot being considered quite sufficient to carry water to side ditches. The method of applying bitumen and constructing these bituminous macadam roads has already been considered in another paper.

Gravel Road

A gravel road will not compact without months of traffic, no matter how well it has been rolled during construction, and maintenance work should begin immediately the road is open for traffic, as with any type of road the method of construction determines its length of life. A gravel that is dumped along the road in numerous piles, no care taken to spread or shape it, simply makes the road that much more inconvenient to the travelling public.

Drainage should be the first consideration. The ditches, the culverts, waterways of all descriptions must have free and unobstructed outlets. The fact that we are simply going to construct a gravel road does not lessen the liability. This province at the present time has a considerable mileage of properly-constructed gravel road that favorably compares with our macadam. The life of the gravel road depends upon the drainage and foundation.

The preparation of the subgrade depends partly upon the traffic expected and partly upon the amount of money to be expended. Proper alignment having been secured, the surface is brought to grade by the use of grader wheel, scraper, and roller. There are two methods of construction generally used—surface and trench. The surface method consists of bringing the roadbed to the proper grade, as explained above, and placing the gravel upon it, care being taken to draw all large stones to the centre of the road that they may be covered by following material; the road is then rolled or allowed to be consolidated by traffic. The trench method is a little more expensive. A trench is made along the centre of the road, material being moved to the sides to act as shoulders to keep the gravel in place; the gravel is then placed upon the road, evenly spread and rolled. When the second course of material is applied it is of sufficient depth to spread slightly over the shoulders, making a more even and better wearing surface.

Road Drag an Efficient Aid

To maintain a gravel road the same system of patrol applies as in macadam; the ruts must be kept filled and the surface smooth. The road drag is probably the best tool for this purpose, particularly the first year after construction, when it should be used after wet weather, while the road is in a soft condition. The road drag will not have the same effect as the road ages, unless a period of wet weather exists for some time. Patching should be done when the road is in a wet condition, as the new material added will bond to the old and compact much better than when in a dry state. It is also easier to locate bad places by the standing water. Care should be taken in filling these holes that the material is only raised above the surrounding surface sufficient that, upon consolidation, the new surface is level. Patching and the road drag, with attention to ditches and culverts, will keep a gravel road in condition until it needs resurfacing.

Fourth Canadian and International Good Roads Congress, Ottawa, April 10-14

THE Dominion Good Roads Association will meet in convention in Ottawa from April 10th to 14th, inclusive. It was originally intended to hold the fourth annual Canadian and International Good Roads Congress at Winnipeg, with the object of promoting the movement in the West. The former conventions were held in Montreal and Toronto, so that the Eastern section had been well catered for. Unforeseen circumstances, however, made it impossible to accept the invitation to go west, and it was then decided by the directors of the Dominion Good Roads Association to meet in Ottawa—a very convenient location for the Ontario and Quebec delegates. The congress will be held in the Horticultural Building, Lansdowne Park.

Wide Range of Subjects

As on previous occasions, some of the best-known experts in the United States will read papers, while our own speakers will represent in a stronger degree the Canadian provinces. The subjects cover a wide range—materials, machinery, construction, traffic, maintenance, organization, etc. The morning sessions will be devoted principally to the consideration of rural road problems, and the afternoon sessions to urban street methods.

Sir George Foster, the acting premier, has accepted an invitation to be present. The Governments of Quebec and Ontario will both be represented by cabinet ministers and officials. The Hon. J. A. Tessier, Minister of Roads for Quebec, and Hon. Walter Mitchell, Provincial Treasurer, have both accepted invitations, and Mr. B. Michaud, Deputy Minister of Roads, and Road Engineers Henri, Fafard, and Fraser will also take part in the proceedings. From Ontario are expected Hon. F. G. Macdiarmid, Minister of Public Works, and Mr. George S. Henry, M.P.P. Mr. W. A. McLean, Deputy Minister of Highways, ex-president of the American Road Builders' Association, and past president of the Dominion Good Roads Association, will supplement his address with an exhibition of slides showing French road scenes. These will be doubly interesting, not only as illustrating France's road system, but also as showing localities over which fighting has occurred.

The provincial road bodies will have official delegates in attendance. These will include Mr. S. L. Squire, honorary president of the Ontario Good Roads Association; Mr. C. R. Wheelock, the new president of the same organization; Mr. Fred G. Pearson, president of the Nova Scotia Good Roads Association, recently formed, and, as a recent article in the Contract Record indicated, alive to the necessities of the province. A list of the speakers and subjects is given herewith.

Discussion Regarding Returned Soldiers

The subject of returned soldiers is also to be discussed. On this point Mr. J. Duchastel, the president of the Dominion Good Roads Association, says:

"When the war is at an end, the condition in Canada will be a very serious one. We will have our returned soldiers to look after, as well as a large influx of immigrants. Very little employment will be available in industrial centres because our factories which are now producing munitions of war will have to seek other fields for their product, and there will necessarily be some delay while they are retransforming their machinery to the production of the articles that will be required. There will also be little employment available on the railways, because this work has been so extensively carried on in the past few years that there are not likely to be any big extensions for the next few years. Therefore, the only employment on a large scale that men will find will be road construction, which should be undertaken not only by the provincial governments, but by the federal government, for the country needs good roads if it is to develop properly. Well-constructed highways, properly maintained, are a benefit to all classes of the community, and the rural districts will probably benefit more from them than any other section, for good roads should always be built with the idea of acting as feeders to the railway lines or to the large commercial centres, thus allowing the farmers to haul their produce to these places at a minimum cost. The congress in Ottawa this year is held with the main idea of appealing to the rural district. We want to have plain, heart-to-heart talks with the farmers, to show them the benefits of good roads from their point of view, and to disabuse their minds of the idea that good roads are built mainly for the convenience of the motorist. This idea has been dispelled in those districts where good roads have been built, and the agriculturist has proved to be the greatest beneficiary from them. I believe the Ottawa congress is going to be a great aid in educating the rural population in this direction, and the splendid list of speakers already announced will ensure that the information given will be of practical value to all public bodies that are concerned with the problems of road maintenance."

The usual exhibition of road-making machinery will be held. A feature will be the heavy equipment, which is becoming increasingly necessary owing to the shortage of labor.

Special Features During Congress

The special features of the congress week are as follows:

Tuesday evening, April 10—Meeting of the Dominion Good Roads Association, with the president, Mr. J. Duchastel, in the chair, to consider the proposed Dominion charter.

Wednesday evening, April 11—Annual dinner of the association, at the Chateau Laurier.

Thursday evening, April 12—Annual meeting of the Canadian Automobile Association, at the Chateau Laurier.

Friday evening, April 13—Annual meeting of the Ottawa Valley Motor Car Association.

Saturday, April 14—Annual meeting, receiving of reports, consideration of resolutions, and election of officers of the Dominion Good Roads Association.

Program of Coming Ottawa Convention of Dominion Good Roads Association

Modern Methods of Maintaining Earth, Clay, and Sand Roads—Paul D. Sargent, Chief Engineer, State Highway Commission of Maine.

Drainage and Foundations—George Hogarth, Chief Engineer, Ontario Public Highways Department.

The Highway Laws of Ontario—W. A. McLean, Deputy Minister of Highways, Ontario.

Bituminous Roads and Pavements—Col. William D. Sohier, Chairman, Massachusetts Highway Commission.

Cement Concrete Roads and Pavements—T. Harry Jones, City Engineer, Brantford.

The Construction and Maintenance of Gravel and Macadam Roads—James H. MacDonald, ex-State Highway Commissioner of Connecticut.

Highway Bridges and Culverts—W. G. Yorston, Assistant Road Commissioner, Province of Nova Scotia.

Safety on the Public Highways—R. B. Morley, General Manager, Ontario Safety League.

Brick Roads and Pavements—D. T. Black, Town Engineer, Welland.

Road Oils—Arthur H. Blanchard, Professor of Highway Engineering, Columbia University, New York.

Wood Block Pavements—A. F. MacCallum, Commissioner of Works, Ottawa.

Modern Road Machinery, Its Selection, Use, and Care—Wimund Huber, Assistant Engineer, Ontario Public Highways Department.

Road Organization—George S. Henry, M.P.P., Ontario.

Granite Block Pavements—W. H. Connell, Chief of Department of Public Works, Philadelphia.

Methods Employed for Making Road Material Surveys—L. Reinecke, Geological Survey, Department of Mines, Ottawa.

The Highway in Relation to Land Development—Thomas Adams, Town Planning Adviser, Commission of Conservation, Ottawa.

J. Duchastel, President
Dominion Good Roads Association

G. A. McNamee, Secretary
Dominion Good Roads Association

Saskatchewan Has Formed Joint Committee of Technical Organizations

FOLLOWING the example set by the Province of Ontario a Joint Committee of Technical Organizations, Saskatchewan Branch, was formed with the seat at Regina, at which the Regina Branch Canadian Society of Civil Engineers, the Provincial Association of Architects, the Society of Saskatchewan Land Surveyors, the Saskatoon Engineering Society and the Canadian Engineers (3rd Field troop) are represented by two members each. Mr. L. A. Thornton, Mem. C.S.C.E., was elected Hon. Chairman, and Mr. J. N. deStein, Mem. C.S.C.E., Hon. Secretary. The committee has started at once to go into the work of devising means as to how the technical abilities of engineers, etc., in the province could best be utilized to assist the Honorary Advisory Council for Scientific and Industrial Research at Ottawa and the National Service Board. A complete census of all technical men in the province will be undertaken at once by means of elaborate cards, giving in detail the special qualifications of every individual. An inventory of natural and industrial resources is also contemplated, though the details of this survey have not been completed yet. Assistance in the vocational training of returned soldiers, advice and help in recruiting for the Canadian Engineers, the working out of a tentative mobilization plan for home defence in connection with this latter body, etc., are some of the points along which this committee is working.

The early formation of a Dominion Committee of Technical Organizations has also been suggested to the Ontario Branch.

Steel Company's New Office

The Pittsburg-Des Moines Steel Company, which operates steel fabricating plants at Pittsburg and Des Moines, Iowa, has recently opened an office at 1275 First National Bank Building, Chicago, Ill. This office is in charge of Mr. Max Whitacre, who was formerly in the Des Moines office of this company. This office had become urgently needed to properly care for the large number of clients which the Pittsburg-Des Moines Steel Company is serving in the Chicago district. This company specializes in the fabrication and erection of elevated steel water tanks for municipal, railroad, and fire protection service. They also manufacture steel plate work of every description, steel for mill and office buildings, and in general a full line of structural steel products. The Chicago office of this company is both an engineering and contracting office, and is prepared to submit designs and cost estimates on the classes of work mentioned above.

Personals

Mr. T. S. Husband has been appointed by the council of Ladner, B.C., as their waterworks engineer.

Col. J. Stewart, of the Canadian Railway Construction Corps, has been given charge of practically all the railway construction forces in the war zone.

Mr. John G. Sullivan, C.E., M.C.S.C.E., chief engineer of the C.P.R. Western lines, Winnipeg, has been elected president of the American Railway Engineering Association, whose annual convention closed in Chicago on March 22.

Mr. A. E. Foreman, former assistant city engineer of Victoria, has been appointed chief engineer to the Department of Public Works of the Province of British Columbia. Previously the offices of chief engineer and deputy minister of public works were both held by Mr. J. E. Griffiths. The engineering portion of the work is now placed in Mr. Foreman's hands, however, while Mr. Griffith continues to act as deputy minister. Mr. Foreman left the civic service of Victoria after four years in office as assistant engineer in October last. He came to British Columbia, at the age of 12, in 1890, and was educated in Vancouver and at McGill University, where he took his B.Sc. in 1903, graduating with high honors. He first went into business in Toronto, but returned to British Columbia in 1907, and for three years before settling in Victoria was engaged in association with various engineering firms in the province, being resident engineer in charge of the construction of the Revelstoke power dam in 1910. Mr. Foreman has been prominent in the work of the Victoria branch of the Canadian Society of Civil Engineers.

Mr. William Henderson, resident architect of the Department of Public Works of Canada for British Columbia, was recently honored by his colleagues in the federal service at Victoria, who tendered him a complimentary banquet on the occasion of the jubilee of his first appointment to the public service. A gold-mounted ebony cane, suitably inscribed in commemoration of the occasion, was presented to Mr. Henderson, together with an illuminated address. The banquet took place in the Dominion Hotel, Victoria, and about fifty officials were present to give their recognition of Mr. Henderson's fifty years of service as a public official.

Mr. William Henderson

Obituary

Mr. T. A. S. Hay, C.E., a prominent professional man and highly respected citizen of Peterboro, Ont., passed away recently, at the age of 68 years. Mr. Hay was born in Peterboro, and there received his education and spent his life. For many years he was chief engineer of the Midland Railway, and afterwards chief draughtsman of the department of the Trent Canal. Later for seventeen years he was Peterboro's city engineer. In military matters the deceased took an active part, and was an officer of the 57th Rangers and a veteran of '66.

Mr. Joseph A. Senecal, a well-known architect of St. Boniface, Man., passed away recently, at the age of 76 years, having been born at St. Marc, Que., in 1841. The late Mr. Senecal had a varied career. Having at different times been engaged in farming, contracting, and store keeping, he finally set up as an architect in St. Boniface in 1891. In this latter profession he was highly successful, having planned a large number of important institutions, including St. Boniface Cathedral, Ste. Anne des Chenes' Church, the Holy Ghost Church, Winnipeg, and the chapel of the Misercordia Hospital, Winnipeg, and many others. His last work was the centre wing of the St. Boniface Hospital, in 1914.

Mainly Constructional

East and West—From Coast to Coast

Brick plants in the eastern end of Toronto are said to be idle because of the inability of their owners to obtain coal, with the result that the building situation may be seriously affected.

Legislative authority has been granted the Council of Carleton County, Ont., to issue forty-year debentures to raise $60,000 for the construction of a bridge over the Rideau River.

Work on the new factory of the British Forgings, Limited, is going ahead rapidly. A large number of pile-drivers are preparing the ground with reinforcing, and the steel work on the largest building, which is being erected by the Hamilton Bridge Works, is well advanced.

Sir John Kennedy, C.E., W. F. Tye, C.E., and R. E. Leonard, C.E., three members of the commission named by the Canadian Society of Civil Engineers to report, at the request of the citizens' committee, on Hamilton's railway problems, recently visited that city and conferred with the city engineer and members of the Board of Control regarding the situation.

The Quaker Oats Company have decided to restore the building of their plant at Peterboro, Ont., destroyed in the recent fire. This is conditional on the city building a bridge over the River Otonabee and making a small grant of land to extend sidings. Steps have been taken to meet the company's conditions.

At a recent meeting of the Council of Langley, B.C., a resolution, addressed to the premier of the provincial government, was unanimously carried endorsing the proposed scheme for a highway along the international boundary, to be known as the International Peace Memorial Highway, and requesting that the Province of British Columbia should take the initiative in the matter and approach the Dominion Government for a grant, to be applied to the building of this road.

Sewer pipe has been received and work is commencing in connection with the new sewer system for the city of Trail, B.C. The first part of the work undertaken is the laying of the sewage outlet. Permission has been secured from the provincial government for the sewage to empty into the Columbia River, and the low-water stage of the river has been taken advantage of to get the work on the outlet done as quickly as possible before the river is in flood. The pipe, supplied by the Alberta Clay Products Company, ranges from 15 inches in diameter down.

Plans for a new St. Mary's Hospital to be erected in Kitchener, Ont., have been accepted, and it is expected that building operations will commence during the summer months. The new institution will cost about $90,000, and its arrangement and equipment will be the most up-to-date. It will have a capacity for fifty beds, and three operating rooms are provided for. A sisters' and nurses' home, together with boiler-house and laundry, will be erected at the rear. The building will be 104 ft. by 48 ft., with additional 12 ft. for septic operating room extension.

The appeal of a deputation of property owners in Ward 7, Toronto, regarding the assessment on the new West Toronto sewer system was heard in the Court of Revision recently. The property owners claimed that on a number of streets where the old sewers were still in use they were being assessed for the new system. The court decided to exempt the property owners on the streets where the old sewers have been utilized as a part of the new system from paying 41½ cents a foot frontage as provided for under the present assessment.

The Joint Sewage Committee of New Toronto and Mimico, Ont., report that the work on the pumping station and the sewage treatment plant is practically completed. The pumping machinery is being installed in the substantial brick, stuccoed, and tiled building on Superior Avenue, Mimico, which has been recently erected, and will be ready for operation shortly. At the disposal plant a special filter is needed, and as this had to be ordered from an English firm, it is doubtful if delivery will be made until after the war. However, Engineer T. Lowes stated that the plant can be operated without this machinery for a time.

A prominent Vancouver cement pipe company has issued a reply to a recent report by the city engineer on the product of the local works. The company maintains that not only are certain reported tests unfair as a standard by which to judge the entire product, but that if compared with other tests of clay pipe the cement product comes out by no means second best. The company further insists that the failure of clay pipe has been much more serious and extensive than the failure of cement pipe, and adds that, while the company has borne every expense connected with replacing its own pipe when notified of failure, it has yet to learn that the manufacturers of clay pipe have done anything of the sort in the like case.

The city of Brantford, Ont., is desirous of having the proposed provincial highway pass through Hamilton, Brantford, Woodstock, and Ingersoll on its way to London and Windsor from Toronto. A committee has been appointed, consisting of members of the City Council, County Council, Board of Trade, Trades and Labor Council, and Motor League, to start activities at once and get in touch with all the cities on the southern and shorter route, with a view to impressing on the Provincial Government the desirability of having the highway pass through this section. The municipalities along the northern route, however, are arranging to petition the government to have the highway run via Brampton, Georgetown, Guelph, and St. Mary's, to London, thence to Windsor or Sarnia, as opposed to the southern route.

The Royal Ontario Nickel Commission, appointed in September, 1915, in their report, which has recently been made public, state that the nickel ore deposits of Ontario are much more extensive and offer better facilities for the production of nickel at a low cost than do those of any other country. Any of the processes now in use for refining nickel could be successfully worked in Ontario, and conditions and facilities are at least as good in this province as in any other part of Canada. However, in view of the fact that practically no chemicals are required, that there is a much more complete saving of the precious metals, especially platinum and palladium, and that electric power is cheap and abundant, the electrolytic method of refining in Ontario is recommended. The Sudbury deposits are also fully discussed by the commission; the extent of the ore reserves is given at 70,000,000 tons of proven ore, and of proven, probable, and possible ore at 150,000,000. With regard to the expropriation of the deposits and plants of the Sudbury nickel area, the report states that this would probably cost not less than $100,000,000, and that there does not seem to be any good reason why the people of Ontario should be asked to advance so large a sum of money

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Halifax, N.S.

Works Department, City Council, plan to construct sidewalks, pavement and curbs costing $25,000. Clerk, A. F. Messervey.

New Toronto, Ont.

Messrs. James, Loudon & Hertzberg, Excelsior Life Bldg., Toronto, want prices and particulars re hot water furnace for pumping station here. Address, E. Proctor.

Redcliffe, Alta.

The Town Council propose to lay about one mile of 10-inch steel or cast iron pipe, and instal extra pumping plant. Engineer, J. E. Askwith.

St. Joseph de Sorel, Que.

The Town Council plan to construct stone and macadam roads. Secretary, J. P. Leclaire.

Sydney, N.S.

The Board of Works, City Council, plan to construct water mains to cost about $8,000. Engineer, R. McKinnon.

The Board of Works, City Council, will start work about April 15 on the construction of sewers costing $15,000. The engineer, Ronald McKinnon, will purchase vitrified clay pipe from 6 to 24 inch diameter.

Toronto, Ont.

Plans, etc., are at Room 6, Works Department, City Hall, and tenders close April 17 for the construction of sewer on Pape Ave. north of Danforth.

The Works Committee decided to recommend to City Council that the sewer on Marguerette Street be reconstructed at estimated cost of $20,000.

Tenders are being received by the Engineer, Frank Barber, 57 Adelaide E., until noon, April 14, for the supply and delivery of the following waterworks supplies : — Tender C-1 — 24-inch stop valves, and tender D hydrants (City of Toronto Pattern). Plans and specification with the engineer.

CONTRACTS AWARDED

Bienville, Que,

Saluste Dube, St. George Street, Levis, has been awarded the contract for drilling well, 300 feet deep, for the Municipal Council, at a cost of $3,000. Pumping machinery still open.

St. Lambert, Que.

The Ideal Construction & General Supply Co., 211 McGill Street, Montreal, has been awarded the contract for concrete pipe for trunk sewer to be constructed by the Town Council. Engineer, H. G. Gibeau.

Railroads, Bridges and Wharves

Brandon, Man.

The Canadian Pacific Railway, Head Office Montreal, contemplate railway improvements to cost $50,000. Purchasing agent, F. E. Gauthier, care of C. P. R., Winnipeg.

Toronto, Ont.

The Temiskaming & Northern Ontario Railway Commission, Head Office, 56 Church Street, has placed $100,000 in the estimates for replacing timber bridges with steel and concrete. Work will be done during this year.

Watson's Homestead, Alta.

The Department of Public Works, Provincial Government, Parliament Buildings, Edmonton, plan to build a bridge over Stoney Creek.

CONTRACTS AWARDED

Montreal, Que.

The following contracts have been awarded in connection with the erection of a $175,000 station by Norcross Brothers, 10 Cathcart St., for the Canadian Northern Railway, Dorchester Street: Excavation, general contractor; roofing, Hickey & Aubut, 93 Dominion St.; paving blocks, Dunn Wire-Cut Lug Brick Company, Conneaut, Ohio.

Moorefield, Ont.

J. Ticker, Harriston, has been awarded contract for construction of 40-foot concrete arch truss bridge on 4th concession of Maryboro, County of Wellington. Engineers, Bowman & Conner, 31 Queen St. W., Toronto.

Windsor. Ont.

John V. Gray Construction Co., Ltd., Confederation Life Bldg., Toronto, has been awarded the general contract for the erection of a $16,000 reinforced concrete and steel bridge for the City Council and the Canadian Pacific Railway.

Public Buildings, Churches and Schools

Beverly, Alta.

Tenders will be called about April 15 for the erection of a $6,000, 2-storey, brick fire hall for the Town Council. Architect, A. Jeffers, McLeod Block, Edmonton.

Bull River, B.C.

Tenders are being received by the Minister of Public Works, J. E. Griffith, until April 13 for the erection of a school for the Provincial Government. Plans and specifications at office of N. A. Wallinger, Government Agent, Cranbrook; R. Hewat, Government Agent, Fernie; Dept. and B. Luck, Secretary of Board.

Burlington, Ont.

The Military Hospital Commission, College Street, Toronto, are considering advisability of taking over "The Brant House" for Military Hospital. General repairs will be made. Furnishings, etc., will be required.

Ellice, Ont.

Tenders will be received by Geo. Reis, R. R. No. 1, Brunner, until 1 p.m., April 18, for the erection of St. Paul's Lutheran Church. Plans and specifications with the architects, Knechtel & Schmalz, Glick Block, Kitchener, and Mr. Reis.

Eugenia, Ont.

Tenders are being received by the Secretary-Treasurer, Jonathan Latimer, until noon, April 10, for the erection of a school for School Section No. 13. Plans and specifications at the residence of the secretary-treasurer and the architects, Forster & Clark, 887 Second Ave. East, Owen Sound.

Fort McMurray, Alta.

The Town Council will start soon on the erection of an $8,000 hospital for which plans have been prepared.

Halifax, N.S.

City Council plan to erect a public comfort station to cost $9,000. Clerk, L. Fred. Monaghan.

The City Council contemplate public bathing house. Cost $5,000. Clerk, L. Fred. Monaghan.

The Children's Hospital Commission, Morris Street, contemplate an addition to their building. Secretary-treasurer, E. J. Murphy, Duke Street.

The Exhibition Commission, City Hall, Manager, M. McF. Hall, plan to repair exhibition buildings at a cost of $32,000.

The Freemasons Hall Ltd., Salter St., are calling for competitive plans for brick or concrete building to adjoin present Masonic Hall, to be used as a commercial suite of offices.

Limerick, Sask.

Storey & Van Egmond, 1013-14 McCallum Hill Bldg., Regina, will call tenders shortly for the erection of an $8,000, 2-storey, brick school for the School Board.

London, Ont.

The Elks plan to secure part of the property of the Woodmen of the World and erect a building for Club house. Chairman of Building Commission, John Bridge, 506 Oxford St. Cost $10,000.

Maisonneuve, Que.

C. A. Reeves, 83 Craig W., has drawn plans for a $175,000 school to be erected by the Roman Catholic School Commissioners, 87 St. Catherine W. Manager, E. Roy.

Pointe Aux-Trembles, Que.

The erection of a $40,000 College is contemplated by the School Board of the Parish. Secretary, Jos. Jean.

St. Aime, Que.

Plans for a $15,000 College to be erected by the School Board have been drawn and sent to the Board for approval. Clerk, P. A. Lapalisse.

Sherbrooke, Que.

Plans and specifications are with the architects, James & Crockett, Whiting Block, who will receive tenders until April 12 for a $30,000, three storey, brick extension to Nurses' Home on Pine St., owned by the Sherbrooke Hospital Board.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **April 11, 1917** **No. 1**

Principal Contents

Page
Editorial 325
Interesting Sewer Work at Victoria 327
Big Canadian Steel Concern 332
The Present Status of the Engineer in Canada 333
Panama Canal Features 335
New Town Hall at Orillia 336
A Peterboro Factory 336
Gold Mine Buildings 337
Derrick Fails from Dry Rot 339
Practical Hints for the Contractor 340
Addition to Factory of Electrical Concern 341
Mainly Constructional 342

Getting the Students Interested

As intimated in a news item on another page, the Council of the Canadian Society of Civil Engineers has decided to organize a technical branch in connection with the students, to deal with matters of interest to that section. It is understood that details of such a scheme are now being worked out, so that operation of the plan may reasonably be expected in the near future. The inauguration of a branch to serve the student membership is a step well taken, for it is doubtful if the Canadian Society of Civil Engineers has as yet made any very strenuous efforts to induce its student members to feel the bonds of association and kinship that should unite the brethren of the engineering profession. The Canadian Society has no less than 575 student members. This represents very nearly one fifth of the total membership. It is evident, therefore, that their interests should receive treatment and consideration comparable with their numbers and consequent importance. True, the society has aimed to develop, in a measure, the student body within its organization; it has promoted the preparation of meritorious papers by student members by offering substantial prizes, but it is questionable if any attempt has been exerted to go a further step and make them feel professional responsibility and kinship with the great body of engineers.

* *

A fruitful field is here afforded to enlist the co-operation of the students, and in so doing the Canadian Society of Civil Engineers will be paving the way for the future greater strength of the society. In a word, it is the duty, then, of any society to keep its younger members well in line and implant such ideals of association and helpfulness that later, there will be reaped the assurance of life-long membership.

We assume that the sole and whole object of the Canadian Society is to advance, in whatever way and in whatever direction may appear best, the interests of the entire civil engineering body. It is further assumed that in so doing the members of the society realize the responsibility that is attached to them in training the prospective members in the high ideals that are universally associated with the profession. If these ideals are to be successfully fostered and jealously preserved, it behooves the society to implant them early in the minds of those who, in time, will be the mainstays of the organization. To this end, then, the student members, who for the most part are not yet out of college, should be given an opportunity to participate in the activities of the society while they are enthusiastic and impressionable. This enthusiasm will make them feel themselves an integral part of the engineering body and not a mere adjunct to it. By giving them the right to assume a certain measure of professional responsibility they will appreciate that the profession is interested in them and anxious to secure their incorporation within the wider professional brotherhood.

* *

In preparing this idea, the Canadian Society of Civil Engineers is taking a step that is assured of fruitful results. Influential as the standing of this society is in the affairs of this country, it can be made even more so by rejuvenation that aims to introduce a little youthful enthusiasm. The trouble, if there has been any, with the Canadian Society, is that there has not been enough relaxation from old-fashioned ideas. A partial step forward, at least, is the inclusion into its professional affairs, of that 20 per cent. of the membership that is represented by the student section.

Misplaced Economy

The Council of the city of Toronto last week referred back for further consideration the proposition of the Toronto-Hamilton Highway Commission to widen the Lake Shore Road section of the new highway at the entrance to the city. This proposed widening called for an extra estimated appropriation of about $100,000 from the city as its share of the additional expense incidental to the improvement.

As the situation stands at present the highway is completed to within a few miles of the city limits. For good and sufficient reasons the city approach could not be constructed last year, and it is the intention of the highway commission to finish it during the present season. The delay, however, proved of material benefit by providing an opportunity for the effects of the new construction to be observed. One very surprising and unlooked-for result was apparent. This was the stupendous increase in vehicular traffic. Of course, the new construction was expected to produce a very large increase, but not so voluminous as actually proved the case. When it is realized that a census has shown as high as 3,500 vehicles per day passing one point, the result of highway improvement is forcibly carried home. This fact led the commission to conclude that at and near the city terminus, where traffic would be more concentrated than on any other portion of the road, an 18-foot roadway would prove entirely inadequate for the traffic. A 30-foot pavement was, therefore, suggested. This, it was believed, was sufficient to cope with the situation and provide for an approach comparable with the city's needs. The extension, naturally, required an extra appropriation, the city's share of which was placed at $75,000 to $100,000. The proposal met with the approval of the Board of Control, but was voted down by the Council. Lack of definiteness regarding the expenditure is said to have actuated the members in the rejection of the scheme, and, if this is true, rightly, we believe. The city should demand a properly-prepared estimate rather than be asked to give what amounts to a blank cheque. Ideas of economy in the minds of some of the aldermen, however, seemed to govern their vote very largely, and, if so, the economy was surely misplaced.

Present circumstances, perhaps, make city councils and administrative bodies dubious about spending money freely. Under the guise of well-meant economy they devise ways and means of reducing expenditures, and anything involving a few thousand dollars is thrown out. It is to be hoped, however, that the Toronto City Council will not let the necessities of the immediate future act as an excuse for nullifying the very large expenditure that has already been made on this splendid highway. In the first place, it is essential to have the last connecting link completed if the work already done is to serve its intended purpose. In the second place, a few months' experience and observation have indicated that the 18-foot allowance is proving too narrow for even that part of the road which carries the least traffic. So much beyond expectation has the use of the road grown that safety alone demands, in part at least, a width greater than at present exists. How much more, then, will 18 feet prove too inadequate at the metropolitan entrance? These two facts together—the inadequacy of an 18-foot roadway and the absolute necessity of making a connecting link—would seem to provide ample proof of misjudged economy in the rejection of the commission's proposition.

First Annual Report of Joint Committee of Technical Organizations

THE first annual report of the Joint Committee of Technical Organizations, Ontario branch, was presented in the C. and M. Building of the University of Toronto on Friday evening, March 30, the chairman, Mr. Alfred Burton, presiding. There was a splendid attendance from all branches of the organization and the greatest unanimity and optimism prevailed that such a representative body of technical men possessed almost unbounded potentialities for serving the Empire, both during and after the war, by lending their trained experience as an assistance in the solution of national problems.

As typifying the comprehensive character of this organization the three main speakers of the evening had been chosen, both as to locality and interests, to represent three entirely different fields of action—Mr. E. P. Mathewson, general manager of the British American Nickel Company; Mr. John Murphy, electrical engineer, Department of Railways and Canals, Ottawa, and consulting electrical engineer to the Dominion Railway Board, and Mr. R. A. Ross, consulting engineer, Montreal, a member of the Industrial Advisory Council.

All the speakers expressed their belief that the time had now arrived when the technically trained men in Canada must come forward and take a more prominent part in pubilc affairs. The development of Canada in the future must be largely a matter for technical men. Our minerals, our water-powers, our resources in land and forest—all call for treatment by scientific methods. It will be criminal neglect if we, as engineers, leave the administration of this land of promise in the hands of professional politicians. The duty of the engineer lies not only in his professional career, but in the broader work of organization and administration for which his training specially fits him.

For such work as this, of equal importance to all branches of the technical profession, the Joint Committee of Technical Organizations appears to be specially fitted. It is an organization of professional men, but its aims are of a national and not in any sense of a professional character. Its activities, therefore, need not in any way overlap with those of the various engineering societies whose aims are purely professional. On the contrary, it may be of the very greatest benefit to those societies, in that, by bringing to bear the greater numbers and more varied experiences of its members, any special aim of any particular society may receive the greater consideration and support necessary to carry it to fruition.

As more than one of the speakers expressed it, this getting together of technical men for one common aim is not the result of a chance idea, but is the natural result of modern and present circumstances. The organization has been called into being because its need is already established. It will remain because it is right. It is the awakening of the engineer to a more perfect realization of his larger duties.

Industry Depends on the Engineer

The importance of the industrial engineer to a country is that the technical soundness of every business and industry depends ultimately upon his work, said Mr. F. W. Lanchester, in an address to the Junior Institution of Engineers, (England). Without sound technical ground work no industry can be built up or will stand; it is the foundation stone on which everything else rests. "Push and go," or "bluff and bluster," may succeed up to a certain point; articles may be copied from others by the aid of the foot rule, the micrometer, and chemical balance; in brief, the technical groundwork may be stolen, but a national industry cannot be so established and held.

The Foundation Company, Ltd., Montreal, have obtained a contract from the C.P.R. for the construction of a culvert tunnel at Keewatin, Ont.

Interesting Sewer Work at Victoria

The Northwest Main Sewer Laid Under Difficult Conditions—Methods of Laying—Work Carried Out by City Engineers' Department at Low Cost

By F. M. Preston, A.M. Inst. C.E.; A.M. Can. Soc. C.E.*

THE lately completed North-West Main Sewer of the city of Victoria was designed to drain, on the separate system, a total area of 2,354 acres, of which 909 acres are in the city proper, 655 acres in Esquimalt, and 790 acres in Saanich, both the latter being neighboring municipalities. The drainage area is divided naturally into high level and low level districts with areas of 2,092 and 262 acres, respectively. The population eventually to be served was based on a density per acre of 30 persons for the city and 20 for the two municipalities, giving a total population of 56,170. Except for the manufacture of the pipe used, the whole of the work was carried out by the Engineering Department under the city engineer, Mr. C. H. Rust, for a cost well below the estimated amount.

Low Level Area

The low level sewage, both from the city and Saanich, is gathered to a collecting tank (Fig. 1) from which it is lifted by three electrically-driven centrifugal pumps of the vertical type to the main sewer through a 12-inch steel rising main. As the sewers in this low district were constructed first it was insisted upon that the collecting tank be made large enough to act efficiently as a septic tank—discharging into the harbor—until the main sewer was completed, and advantage was taken of this to so design it that when converted to a pumping tank the more settled portion of the sewage would be pumped separately from the effluent by a coarser type of pump, as it has been found that the life of a bronze impellor is very short when working in the rather sand-laden sewage of the district, Victoria, like many other places, being troubled with infiltration of ground water, largely due to imperfect connections. The tank has three separate settling chambers, with one dry pump chamber at each end, the controls to the motors being operated automatically in the usual manner with floats. At present two clean water pumps, each operating from a separate chamber (provision being made for a third) have been installed, and one sludge pump. The second clear water pump only comes into action when the first tank is full and overflowing. Some trouble was experienced with the pumps drawing air over their inlets in the tanks, even with $2\frac{1}{2}$ feet of water over them. This was overcome by fixing dished iron plates 2 ft. 6 ins. in diameter over the mouths of the suction pipes which are set horizontally through the division wall.

The tanks are constructed of reinforced concrete of heavy construction, as they are situated under the

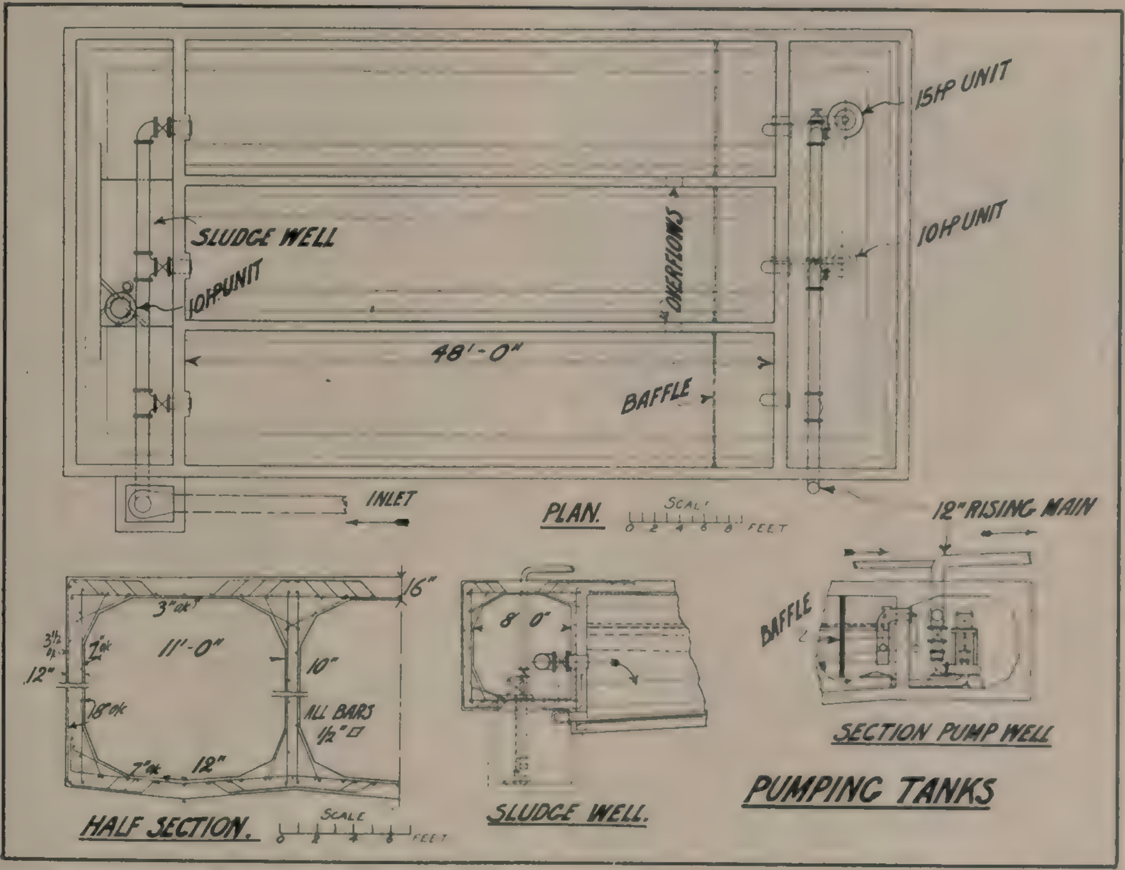

Fig. 1—Details of collecting tanks. Reinforced concrete construction with three separate settling chambers and two dry pump chambers.

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* Assistant Engineer in charge of sewers.

road, at the bottom of a ravine, and will eventually have at least 40 feet of fill on them. Work was commenced early in the year, and as the ground was clay, overlying steeply inclined rock, particular care was taken with the timbering for the excavation, Fig. 2, which also shows the chute down which the concrete was taken from the top of the hill where it was mixed, to save hauling of materials. This was probably not a saving in the end, as when the tanks were finished a considerable leakage of ground water, which stands most of the year a foot or so below the roof, developed. This leakage was traced to planes of separation in the concrete, in all probability due to the long length of chute, and the whole of the inside of the tanks, after they had been in use as septic tanks for some time had to be rendered in cement. A mixer over the tanks and a chute for the material would have been the better policy. The cement rendering has proved quite successful, and they are now practically water-tight; the walls were first washed with a one to six mixture of muriatic acid and then hosed down to remove all traces of the acid, picked all over to give a tooth and then the cement plaster applied.

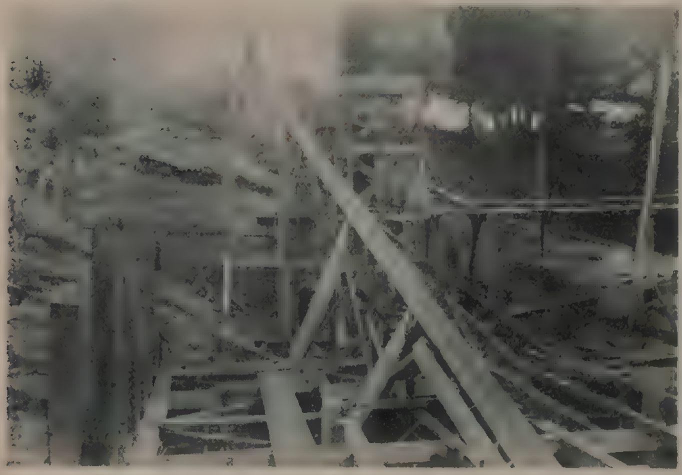

Fig. 2.—Excavation for pumping tank, showing timbering and concrete chute from mixer located on top of hill.

The tanks are sludged about once a week or at short enough intervals to keep them inoffensive. The sludge main discharges into the settled sewage rising main and both pumps are run together when sludging takes place, in order to prevent any settlement in the main sewer, into which the common rising main discharges, and the cleansed tank is then washed out with clean water.

The entire sewer is laid with reinforced concrete wet mix pipe manufactured locally to the department's drawings and specifications, see Figs. 3, 4 and 5. The reinforcement was a single ring of A. S. W. Co.'s wire mesh placed one inch from the inside circumference of the pipe. They have the usual joints for pipes of this size and were made in 4-foot lengths. A steel band was sprung round the inside for jointing and the joint poured with cement grout. The following is a table of sizes, thickness of shells and amount of steel specified, a 1:2:4 mix of coarse sand and pea gravel, machine mixed, being used with steel moulds having cast iron bottom and top sections:—

Size.	Thickness.	Area steel per ft. run of pipe.
27 in.	3½ in.	.102 sq. ins.
30 in.	3½ in.	.123 sq. ins.
33 in.	4 in.	.139 sq. ins.
36 in.	4 in.	.170 sq. ins.

The pipe appears amply strong except for one short section of 36 in. pipe under a fill of about 24 feet, in blue clay, which had slipped laterally for about 20 ft. back on either side of the centre line, after the pipe was laid and backfilled. In this section cracks are apparent in the sides of the pipe and it has been forced up slightly out of grade; this section has been kept under observation, and as there is no percolation of water and the cracks are not opening further, no collapse is anticipated. The pipes were not rendered on the inside, but in some few cases they received a brush coat of cement, and though not as pretty as those of some of the well-known manufactures, are quite satisfactory as to watertightness and smoothness.

In the open cuts a track was laid over the trench and a 4-wheeled car fitted with a Triplex block and lifting hook was used for laying.

In the tunnels the pipes were taken up to their position on trolleys running on rails and on reaching it were lifted by the hook attached to a small two-wheeled car fitted with a screw wheel raising gear running on a twin channel iron beam, supported at one end on the pipe already laid and at the other end by an "A" frame—carried forward to the end of the pipe and laid. This enabled the rock filling that was used in the tunnels to support the pipe on the rock bottom, to be kept well ahead of the pipe laying. The method was satisfactory and economical but the screw raising gear was slow and might be improved upon.

The tunnels were only backfilled when the roof was in earth, and the manholes, which were built of reinforced concrete at the shafts, were provided with cut-off walls at the tunnel faces with a concrete pass-

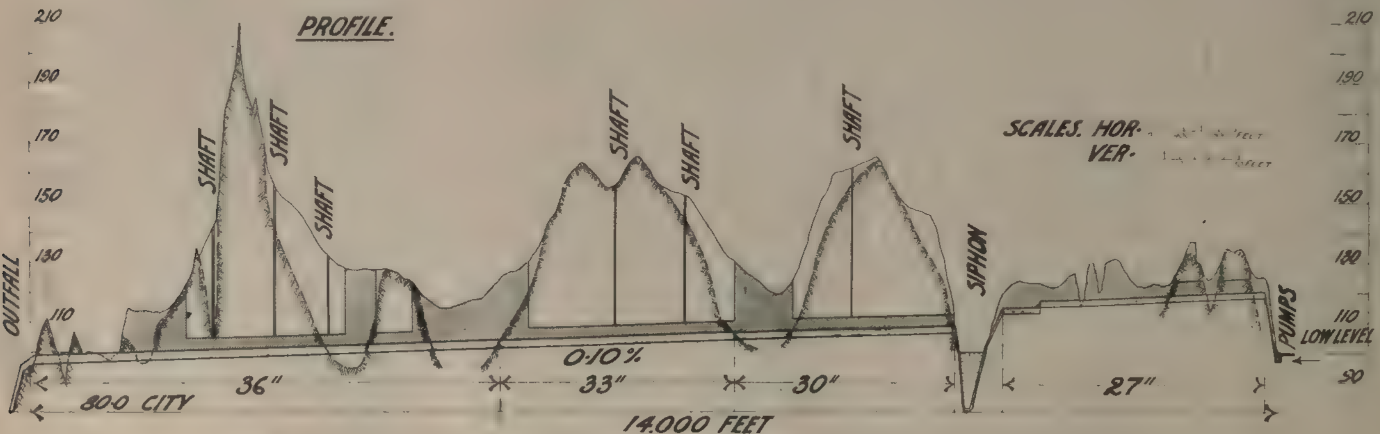

Fig. 3.—Profile of sewer work, showing location of open cut and tunnel excavations and indicating sizes of pipes.

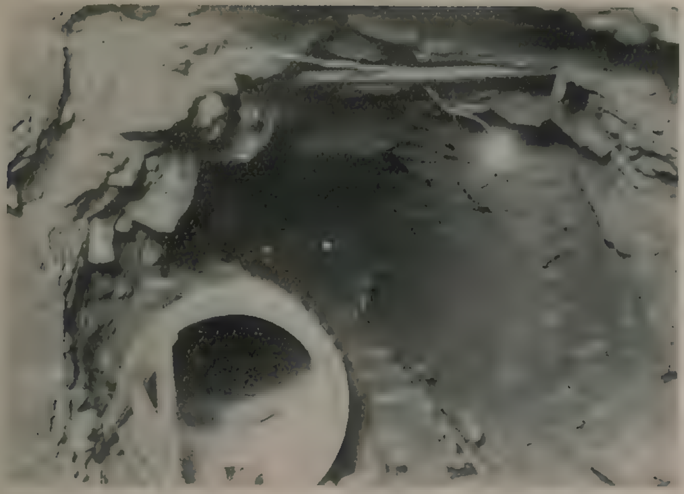
Fig. 4.—A 36 in. pipe in rock tunnel; space for surface drain alongside.

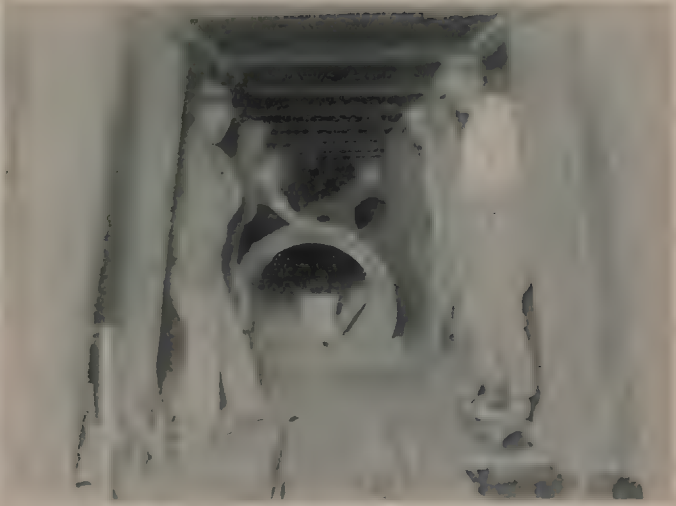
Fig. 5.—A 33 in. surface drain and 16 in. sewer in an earth tunnel.

age through the fill leading to manway doors in the manhole walls, so that access can always be had to the tunnels for inspection and repairs. Drainage is provided through the cut-off walls and fill by stoneware pipes. All these manholes were designed for the full hydraulic pressure possibly occurring.

Practically all of the tunnel work was in solid granite rock; the drilling was done with electrically-driven air compressors, and the shafts were served with electric hoists. No particular difficulties were met with, the rock being very free of water, and except for the re-timbering of one deep shaft, no work was lost. All the tunnels met practically exact to line and grade, and credit is due to the engineer in that charge, who received no independent check on his work, but checked himself by running two separate lines at the same time.

In one section of the work the sewer is paralleled in the rock tunnel by an open surface water channel and in the open cut by a reinforced concrete surface water pipe. The surface drain leaves the main tunnel by a branch tunnel partly in rock and partly in earth, and is paralleled in this by a 16-inch vitrified branch sewer joining the main sewer where the surface drain leaves.

Outfall

The 36-inch riveted steel outfall, Fig. 6, was jointed in one length on shore and floated into position over the already constructed concrete piers on the rock bottom, filled with water and sunk in place; the outer end being steadied in its correct position by a pile-driver. The concrete piers were built by a diver who brought them up to the correct grade, the support at the shore end to well below low water mark being built solid. The concrete was mixed very dry on shore and the bags wheeled out on a floating stage, anchored over the line by cables to pile dolphins and lowered to the diver beneath. After the pipe was in position it was weighted down and held permanently by bag work over the piers and the shore end. A large number of the bags were spiked together with a ½-inch bar long enough to penetrate three of them. The work is standing well and shows no deterioration at present. With the floating working stage used for constructing the piers a calm sea was necessary, and fortunately the weather held fine during the operations.

Tenders were called for this portion of the work, but were refused on account of their high nature, the work eventually being done by the department at a very much lower figure. It is expected that the life of the exposed steel pipe at the lower end of the outfall will not be long, owing to the action of the sea water, but at any time this can be relaid at a lower cost altogether than cast iron pipe would have entailed in the first place.

Syphon

As can be seen from the profile, Fig. 7, there was no economical way of obtaining a washout, and as the flow through it for some years was bound to be small, it was deemed advisable to provide some means of effectually flushing. This end has been obtained by

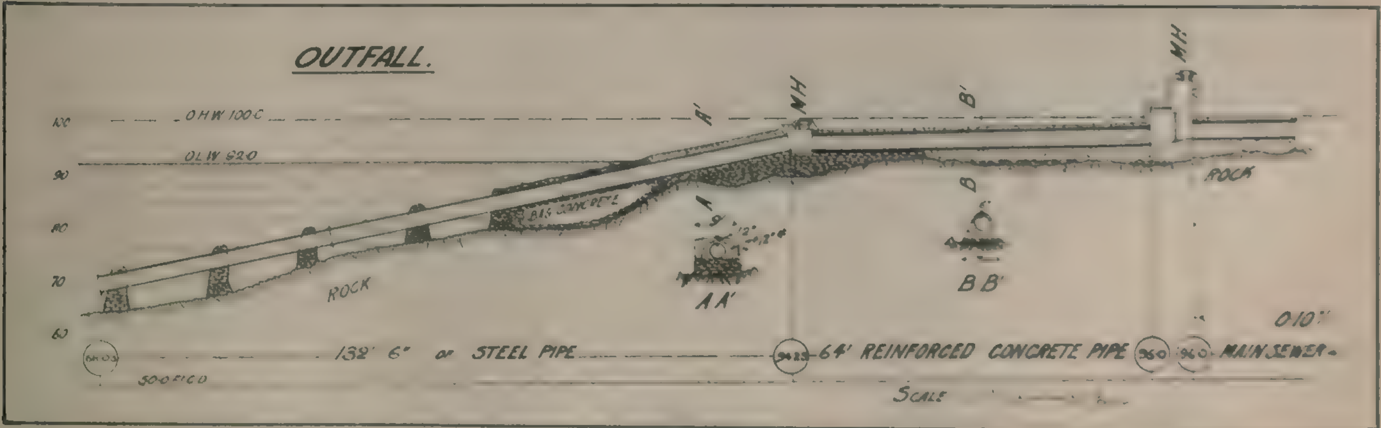

Fig. 6.—Outfall of 36 in. riveted steel pipe laid on bag work concrete piers.

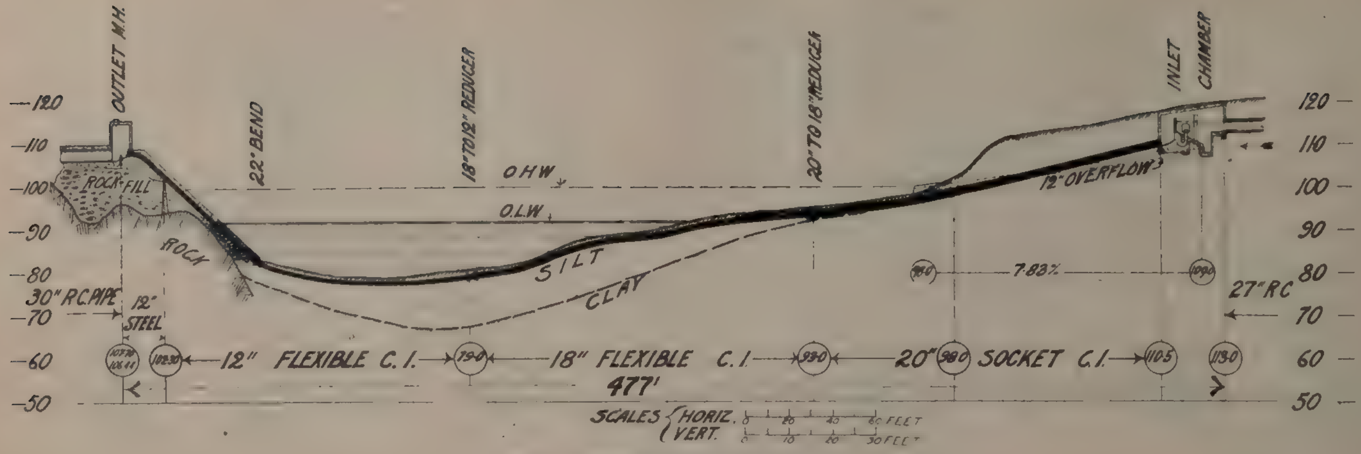

Fig. 7.—Profile of twin inverted syphon.

so designing the sizes of the twin pipes used that the velocity is greatest at the bottom and in the ascending leg. Two automatic flushing syphons are placed in a chamber at the upper end which holds back the sewage in a section of the main sewer, so designed as to act as a storage tank with a capacity of 12,000 Imperial gallons. At present, with the minimum flow, about eight discharges per day take place, with maximum velocities in the syphon of 8.8 feet per second in the 12-inch, 3.9 feet per second in the 18-inch, and 3.17 feet per second in the 20-inch portions, and the sewage is either stationary or running at these velocities. The inlet chamber is provided with a sand pit with washout and overflow into the creek, and a galvanized iron cable has been threaded through each pipe in case of blockages. Some trouble was experienced in getting the pilot lines through for these, but finally a torpedo-shaped cedar float with a metal umbrella attached to the front end and acting as a piston was used successfully. A good deal of time was spent in adjusting the flushing syphon to work properly, the skirts of the bells had to be lengthened so as to cut down the rate of flow at the end of the flush, in order to allow the inverted syphon time to drain the water level below the outlets of the syphon and vent them properly; the length of the air pipes needed considerable adjustment also.

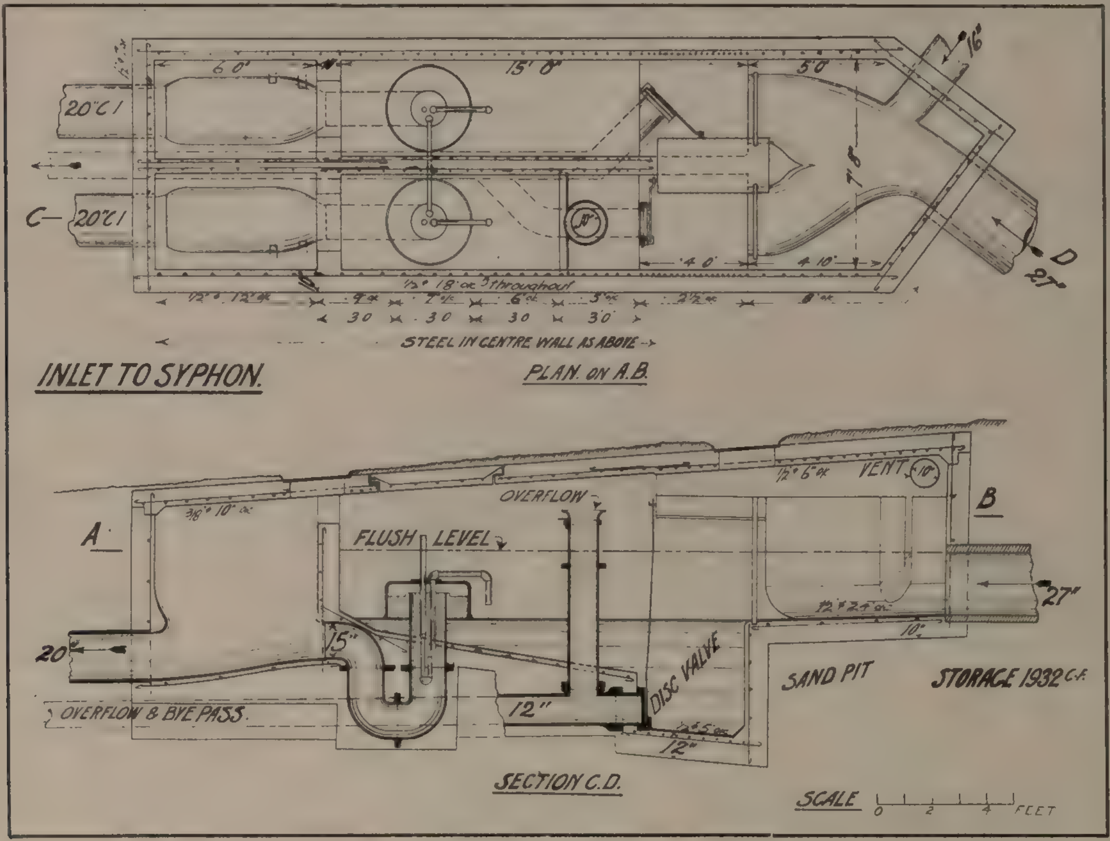

Fig. 8.—Details of inlet chamber to syphon.

The cast iron pipes were obtained second hand, having been previously used for water under Second Narrows, Vancouver, and have a flexible joint run with lead. The 12-inch and 18-inch were laid from two scows having a chute between; laying was commenced at one side of the creek, the pipe jointed being on the scow, passed down the chute as the scows were moved

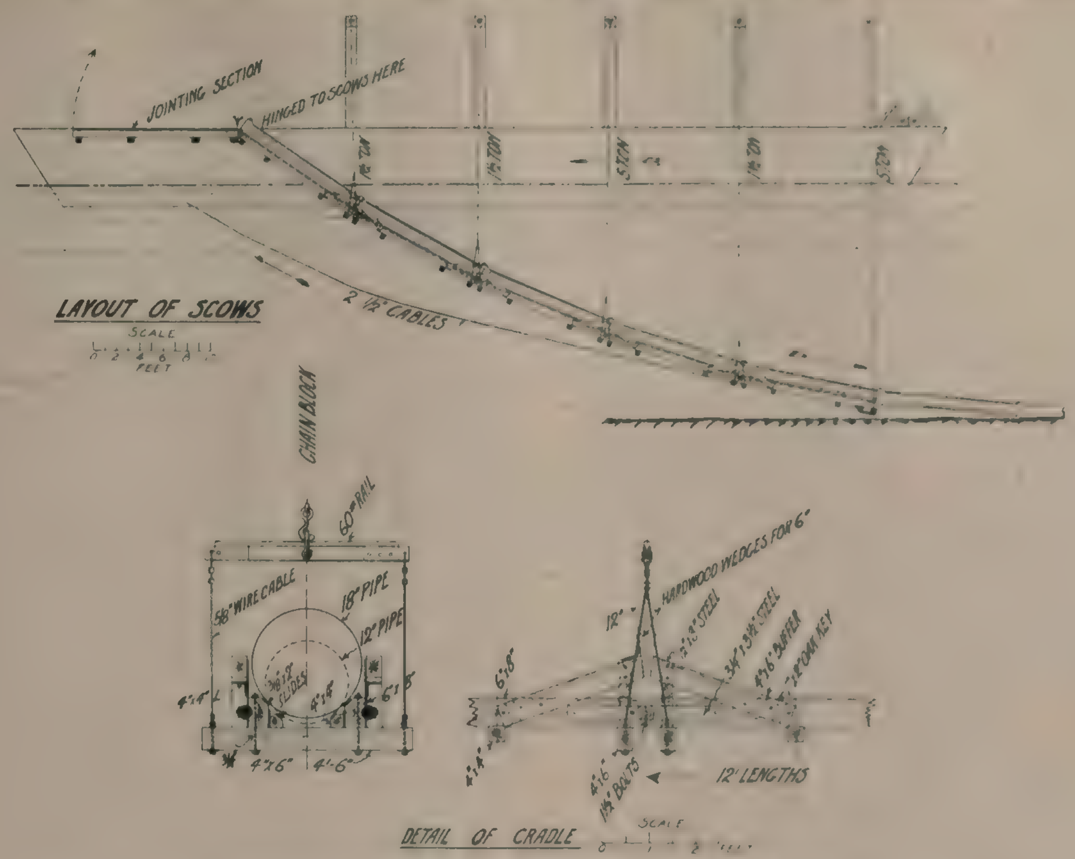

Fig. 9.—Syphon pipes were laid from two scows having a chute between.

across. Fig. 9 shows the layout of scows and chute, and Fig. 10 the outlet end with 12-inch flexible joints in foreground. The two lines were laid separately and afterwards hydrauliced down into the mud to a firm bearing with the stream from fire engine shown in photograph.

Costs

The entire cost of the work, including low level mains not shown on the profile, was $302,470, not including engineering costs. The cost of the outfall was $2,934, of which $1,349 was material, the rest labor, including $318 for diving work. The steel pipe cost $313 jointed up, with bulkheads fixed ready for laying.

The inverted syphon cost $8,364 in all, made up as follows:

	Labor	Material	Totals
12 in. and 18 in. pipes	$2,142	$2,872	$5,014
20 in. pipes	521	881	1,402
Inlet chambers	877	1,070	1,947
			$8,363

The cost of the 12-in. pipe being $585, 18-in. $938, 20-in. $734.

The costs per cubic yard for an average depth of 16 feet open cut excavation were, for labor only—rock, $3.65; hardpan, $1.69; earth, $0.89. Tunnel work in rock cost $8.50 per lineal foot of 6 ft. x 7 ft. tunnel for labor only, the total costs, including pipe, being, for rock tunnel, about $24, of which labor was $12.75. The costs of the reinforced concrete pipe were, delivered on to job:—36-in., $2.80 per foot; 33-in., $2.50 per foot; 30-in., $2.10 per foot; 27-in., $1.95 per foot.

The total cost per cubic yard of reinforced concrete was $17.70, of which labor on concrete was $1.38 per cubic yard, labor on forms $0.11 per square foot, placing steel 1.2c per lb. Cost of materials was, for concrete, $6.73 per cubic yard; form work, 5.8c per square foot; steel, 2.34c per pound.

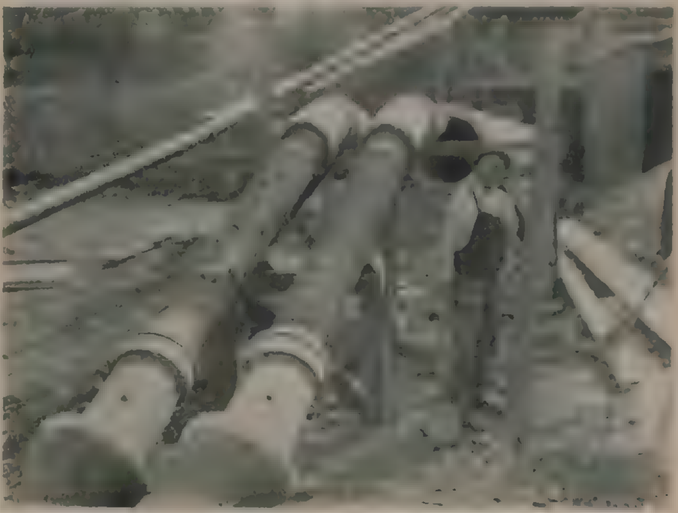

Fig. 10. Outlet end of syphon, showing 12 in. flexible joints in foreground.

Careful cost accounts were kept and weekly returns of each foreman's work required to be made to the engineer-in-charge.

The work was under the direct control of Mr. A. E. Foreman, the late assistant city engineer; Mr. H. R. Brown was in charge of line and grade, and the author was designing engineer.

Big Canadian Steel Concern

Armstrong-Whitworth Company's Plant Contains Last Word in Engineering Equipment —Size Recently Doubled

By M. J. Butler, C.M.G[*]

IN the fall of 1912 General Sir Percy Girouard, K.C.M.G., D.S.O., one of the directors of Sir W. G. Armstrong Whitworth and Company, of Elswich, Newcastle-on-Tyne, Manchester, paid a visit to Canada, his home, with the object of seeing what the prospects justified in the way of establishing a branch of this well-known engineering firm in Canada. To this end Sir Percy asked the writer to visit the company's various works in England and advise: (1) What business could be best developed in Canada, (2) Where the plant should be located, and (3) Probable cost.

The writer visited England and made a close study of the manifold industries carried on by Sir W. G. Armstrong Whitworth and Company at Elswich and Manchester, and recommended the installation of a crucible steel plant for the manufacture of high-grade tool steels, high-grade steels, and in addition thereto a plant for the manufacture of small tools, such as taps, dies, twist drills, milling cutters, hobs, gauges, etc.

Excellent Location

After giving careful consideration to all the factors, Montreal was selected as the place to locate. Owing to the impossibility of securing land located along the river front anywhere on the Island of Montreal, at reasonable cost, (for the year 1912 was during the height of the land boom), a site was selected near the town of Longueil, which lies within the harbor limits of Montreal, and is directly opposite the industrial portion of the city. Having regard to the future growth of the plant a large area was purchased, 183 acres, with a frontage on the south shore of the St. Lawrence River of 3,000 feet. The area in question is underlaid closely with rock, so the foundation problem is satisfactorily settled for all time. The elevation of the ground is such as to put it above flood troubles and its close proximity to the town of Longueil, with its excellent schools, churches, water supply and sewers, makes it an ideal location for an industrial plant.

All the buildings are of high-class fireproof construction with steel columns and trusses, reinforced concrete roofs and side walls. The greatest care has been taken to insure ample natural light by sidelights and roof monitors and flat skylights. The floors are mainly of concrete on rock. The heating system is of the vacuum return type, using exhaust steam, and even during the coldest winter months the men work in comfort.

Enlargement

During 1916 the buildings were enlarged to double the previous area, for the purpose of providing room for the machinery to manufacture steel tires for locomotives and car wheels and for the manufacture of the steel rolled wheels, all of which will be installed early in this year.

Steel Manufacture

The capacity of the plant is measured by the installation of two 18-ton open-hearth furnaces working in conjunction with three 6-ton Herroult electric furnaces and one 3-ton Herroult electric furnace. At present all the steel turned out in the above furnaces is supplied under contract to the Imperial Munitions Board, for shell blanks. Rock drills are also manufactured, solid and cored as required.

It is the intention of the company to furnish only steel refined in the electric furnaces for tire wheels, drills, etc., and such alloy steels as the requirements of the country demand, confining the crucible to the high speed and carbon tool steels. Throughout all departments the last word in tool making and machinery is the word; the greatest care has been taken in selecting the best machine for the work.

Sanitary Arrangements and Water Supply

Clean and wholesome closets, basins, etc., have been provided in convenient places in the shops. For drinking purposes the water supply is taken from the town of Longueil, all manufacturing requirements being met by our own plant. The tank is 70,000 gallons capacity, 40,000 being permanently retained for fire protection purposes. The pump house contains two electrically-driven pumps of 550 gallons each. The whole plant, land, etc., as it will stand when completed by July 1, 1917, represents a cash outlay of $2,500,000.

Personnel of the Company

The president of the Canadian company is General Sir Percy Girouard, K.C.M.G., D.S.O.; vice-president, George G. Foster, K.C., of Montreal; managing director, M. J. Butler, C.M.G., of Montreal; Canadian director, H. B. Walker, Esq., manager of the Bank of Commerce; English director, Right-Hon. Sir George Murray, G.C.B., I.S.O. By the recent death of Mr. H. Smith Carrington the Canadian company loses one of its best friends, the vacancy at this writing not being filled. The entire stock is owned by Sir W. G. Armstrong Whitworth & Company, Limited, except the qualifying shares owned by the Canadian directors. Lawrence Russel, Montreal, is the secretary-treasurer and sales manager; J. H. W. Whinfield is secretary in London, England.

All the steel work was manufactured by the Dominion Bridge Company, Lachine, Que. The first contract for the building in 1913 was let to E. G. M. Cape, Limited, Montreal, while the contract for the enlargement was let to Quinlan & Company, Montreal.

The Montreal Catholic school commissioners declined to allow one of the school boards to borrow an additional $5,000 required to purchase American brick, necessitated, it was stated, by the shortage of local brick. The commissioners told the school board to use Montreal brick.

Although only a very few large steel cargo ships were being built in the United States before the war, within the past two years the Pacific Coast yards alone have built, or contracted for, sixty-five steel ships of 8,000 to 10,000 tons cargo capacity, of which more than fifty are to be equipped with geared turbines.

Mr. T. O'Sullivan has informed the Montreal Board of Control that on account of the rise in the price of materials he cannot complete the contract for the construction of the Lasalle bridge and headgates of the aqueduct. He asks for the return of his deposit, cost of material on the ground and payment for work already done.

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[*] Managing Director, Armstrong-Whitworth & Co., Ltd.

The Present Status of the Engineer in Canada

By Mr. W. F. Tye[*]

YOU all know that lately, for some time past, for a year or two, there has been a growing dissatisfaction with the standing of the engineer in Canada. This is expressed in various ways. Some lay the blame on the Canadian Society of Civil Engineers—and no doubt some of it belongs right there. Some put it on the government; they say the government has appointed very many commissions, and that they officer these commissions with all kinds of men except engineers—I am now referring to engineering commissions, of course; that they have put on these commissions lawyers, politicians, and farmers—anybody but engineers—and they blame the government for that. I want to ask you—is the government to blame in this matter, or who is to blame? Some, again, talk of the importation of American engineers, of aliens; they say the government are not doing what they ought to do; that Canada has sent a great many men to the front. I believe there are now between seven and eight hundred of our members who have offered their lives and blood in defence of our country. They say that we who stay at home are aiding the government in every way we can; that we are paying our taxes, we are aiding the war loans, we are standing the increased cost of living; that we are doing everything in our power to aid the cause of civilization, while the American engineers, whom the government appoint so frequently, are not helping in any way, except in the way of giving munitions; they are not giving their lives and blood to the cause of civilization as Canadians are; and, therefore, a great many people, especially under these circumstances, say the government should not go afield for expert advice in engineering matters, but should consult engineers nearer home.

Canadian Engineers Do Not Get Their Due

If these things are true, gentlemen—and I think most of them are—I just want you to ask yourselves, seriously, whose is the fault? Is it the fault of the government? Is it the fault of the public? Or is it the fault of the engineers? Is it your fault, is it my fault, is it the fault of the Canadian Society of Civil Engineers, or whose is the fault? Just ask yourselves that question seriously, and if you should decide that it is our fault, then ask yourselves—why?

In private life, there is no doubt whatever, the engineering profession has advanced by leaps and bounds. I can remember when I started at engineering. I suppose it is quite a long time ago, but it does not seem so very long. In those days any engineering education that I had I took very good care for a time to hide it. You did not go and advertise that you had been studying in a college for engineering because then the whole idea was that the engineer must be a practical man, and if he had a college education he was supposed to be no good. You know, gentlemen, conditions have changed very materially in that respect—very materially, indeed. The rate of pay has increased very materially. My friend, Sir Collingwood Schreiber, just before we came in, was telling me a story about how an engineer had made some important report to the government. At the end of the time he came to Sir Collingwood and asked him what he should charge for it, and Sir Collingwood told him he thought it certainly ought to be worth $25 a day. And when the minister saw that, he threw up his hands in horror. He said it should be $5 or $6 a day. And Sir Collingwood went on to illustrate. He said: "Well, if it were a lawyer, you would not think anything of paying a young lawyer $25 a day. Why shouldn't you pay an engineer $25 a day?" And the minister said: "Oh, yes; but, then, a lawyer is an educated man!" That was what he thought of the engineer. There is no question nowadays when an engineer is making a report to the goverment of giving him $5 or $6 a day. A good many of them making reports to the government get $100 a day, which is a very distinctive advance.

Engineers Lack Proper Public Standing

But, while all this is true about our private standing with the people whom we serve as individuals, or with the government that we serve, our public standing is not good. I am sure you will all agree with me that our public standing—I mean our public standing as a profession—is not good. We are not put on government commissions; we are not even consulted nowadays on the higher technical aspects of things, by the government. And the question is, Why?

If you want to get any good out of the Canadian Society of Civil Engineers you must get it by service. If you want to get any good out of public recognition you can get it only by service; you can get it only by serving the public. Now, understand, there was one thing I meant to say in starting, but which I did not say, and I shall say it now. In speaking about the government I want it distinctly understood that I am not in any way trying to make political capital for anybody in this respect. My remarks in regard to the government are entirely not in any party sense whatever. I am simply referring to it because it is necessary to refer to the public standing of the engineers and their standing with the government. Now, the members of the government are all human beings like ourselves. We look upon the government as something set apart, but, after all is said and done, the members of the government are only human beings, and, like all other human beings, they always take the easiest course; they seek the line of least resistance, as all the rest of us do. Now, if the line of least resistance, when it comes to appointing commissions, is to appoint lawyers, or farmers, or politicians, men who have been serving their country and who as a result of their services should have these rewards, then whose fault is it that we are not appointed? It is our own fault, because we have not been serving the public.

Why the American Engineer?

Then, when the government goes to the United States for its engineering service, again it is seeking the line of least resistance. The Americans, you know, are a very great people—a very great people, indeed. And one of the attributes of a great people is to have a thorough belief in themselves. The Americans have not yet quite reached that stage of belief in themselves that the English have, where they believe in themselves without saying it, taking it for granted that everybody else believes they are the greatest people in the world; the Americans insist on their being the greatest people, and they tell everybody that they are—insist upon it on all occasions. They are not the least bit modest about what they say. They say they are the greatest people in the world, and their engineers are the greatest in the world. All of us are prone to take the other fellow at his own valuation, and if the Americans insist that they are the greatest engineers in the world, and we don't insist that we are equally good, when the government want engineers it is natural for them to go there—to go to the people who say they are the greatest engineers.

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[*] Extracts from an address before Ottawa Branch, C. S. C. E.

Now, there is only one way in which we can counteract this tendency of the government, and that is to insist that we Canadians, who are doing everything we can for Canada, must have our fair share in these government appointments that are going about. We must tell them what is absolutely true—that we are, man for man, just as good engineers as the Americans. There may be, of course, some particulars in which they have experience and in which we, as a younger country, have not had experience, and, therefore, in those respects it may be all right for the government to go there for men. But if we want our fair share in this business of advising the government we must firmly—very nicely and politely, but firmly—tell the government we do not propose to stand for that sort of thing. We have rights, but in this world if you want your rights you have to fight for them. Nothing good comes in this world except by work. If you want to have a standing with the public you have got to serve the public, and you have got to tell the government frankly that we are just as good engineers as the Americans, and we propose to have our fair share of the business that is going.

Engineers Show Little Interest in Public Questions

Now, as I said, the reason that this condition exists is that while the engineer has in private a very good standing, and his standing is improving at all times, yet in public estimation I am not quite sure we are not going backward—that is, our standing is not as good as it used to be. In the old days, thirty or forty years ago, there were some outstanding engineers who had considerable say in the government or things having to do with the government. I am not quite sure that the engineers nowadays have quite that standing, and, I say again, I think it is entirely our own fault, because we do not take part in public discussions. Take, for instance, our own Canadian Society of Civil Engineers. How many times in our discussions on the papers that are read, how many times are there discussions on public questions? I do not mean taking one political side or the other, but just discussing the great, big problems that are before Canada. Very rarely, indeed. I do not think that in the Parliament of Canada to-day there is a single engineer; there may be, but I do not know of any. I do not believe there is one in the Senate. Now, if we do not take part in discussions, if we do not take part in the government of the country, how can we expect to have a public standing You know how the government of this country is conducted. It is a pure democracy, supposed to be a government of the people by the people. In Parliament there are many members who are farmers, many who are doctors, many who are lawyers—there are all but civil engineers. It is the same way in the Senate. If that is the condition, it must be due to ourselves that we are not there. Is it any fault of the government or of the people that we are not?—that we have not the public standing we ought to have? It is our own fault, and it is a fault we have to correct if we want this public standing.

One reason, it seems to me, why we are in this condition is that we lead what I might call lives that are entirely too self-centred. Every one of you is thinking of your own particular little job, whatever it is, whether it is working in one of the departments or whether you are chief engineer of a railway, or working for a railway or canal, or a private company. You are thinking of that and giving your whole undivided attention to that and serving the private interest to the best of your ability, but you are not taking part in the public discussions.

Public Problems for Engineers to Solve

It seems to me that amongst all the different people in Canada the engineer, by his training, is the one best qualified to lead and direct public opinion. You know, in a young country such as we have in Canada, most of the public problems—not all of them, of course, but a great many of the public problems—are engineering problems. You know that this is the engineer's age; that the engineer to-day is the most important man in the world. You know that this war is an engineer's war; instead of being a soldier's war it is an engineer's war. It depends on the gunnery and on the trenches, and all that, a great deal more than on the individual soldier. This is an engineer's age, and engineers should be leading the public and guiding them. All of you know that from your training, from your very training, you are always dealing with these new subjects. For instance, if a private company wants to develop water power, we will say, they cannot do it without going and getting an engineer to report on it, and he must report not only on what might be called the purely construction features, but must also report on the business end; must tell whether this power company is going to be a success or not, and must forecast its earning capacity; and if they have a favorable report from an engineer, his standing is such that they can raise any amount of money, and without that favorable report they cannot. It is the same with any other enterprise—the engineer is the man who must tell whether the thing is going to be a success or not. If we can do that with private enterprises, why not with public enterprises? Why are we not reporting to the public on all these things? We are not, and it is entirely our own fault; and if we are going to have this standing which the engineer should have—the public standing, I mean—then we must take part in the public business of the country. We ought to mould public opinion instead of being self-centred, as I say. Why, the very objects and aims of the Canadian Society of Civil Engineers are self-centred. I have here the opening paragraph of our charter, which reads:

> "Whereas the persons hereinafter named have by petition set forth that it is desirable that they, together with such other persons as may be hereinafter associated with them, be incorporated into a society by the name of the Canadian Society of Civil Engineers, having for its object and purposes to facilitate the acquirement and interchange of professional knowledge among its members, and more particularly to promote the acquisition of that species of knowledge which has special reference to the profession of civil engineering, and further to encourage investigation in connection with all branches and departments of knowledge connected with the profession."

Aims Should Be Broadened

That is what we were organized for. Well, now, those are all very fine aims, indeed, but are there not some other aims we ought to have? Is there not the possible dissemination of this knowledge, the guidance of the public in the big engineering questions? There is not anything whatever said about that, and we as a society and as individuals, if we are going to have this public standing; have got to change all that. And, gentlemen, it is not only in governmental affairs we must do that; we must also do it in provincial and municipal affairs. Municipal affairs present certainly a very wide field, a broad field—one in which we can do a tremendous amount of good. It is not an exaggeration to say that municipal government on this continent is probably the worst in the world. Now, are not we to blame for that in a certain measure? We are engineers, who are dealing, who should be dealing, with such questions as that, and we take no interest in it. Don't you really think, yourselves, we should have a very strong interest in it?

What I wanted to drive home to you is this: that the only way in which you can get any good out of anything in this world is by work. The only way in which you can get any public recognition whatever is by work. If you want recognition from the public you have got to work for the public. If you do not want to work for the public you won't get recognition. If you do not take your fair share in the load of governing this country you cannot expect to get public recognition. And I do not know of any body of men in all Canada who are better fitted by their training to guide public opinion than the engineers of Canada, more especially as so many of our great public problems are engineering problems.

Panama Canal Features Described to the Canadian Society of Civil Engineers

From the technical and lay points of view no paper presented or address made during the present session of the Canadian Society of Civil Engineers, Montreal, exceeded in interest the talk on March 22 by Mr. Henry Goldmark, an old member of the society, who resided for several years in Montreal and carried out several important engineering works in Canada. His subject was the Panama Canal, the gates for which were designed by Mr. Goldmark. The attendance was unusually large, and the speaker received an enthusiastic welcome, particularly from his old friends, including some from Ottawa. The address took the form, for the most part, of a running commentary on a very large number of slides from photos taken for the United States Government. The outstanding features of the undertaking were comprehensively dealt with, and Mr. Goldmark also lightened his speech with quiet humorous touches.

After a brief historical review, in which a tribute to the excellent work done by the French engineers on the canal was made, Mr. Goldmark described in detail the Gatun and Pacific locks, the coaling station—the largest in the world, and capable of dealing with 2,486 tons per day—the breakwater, the dams, the dry-dock, emergency dam, and the Celebra cut. He stated that as the result of experience, it was now definitely known that the lock canal, as recommended by the board of engineers, was the best type for navigation purposes, and that the sea level type was not as efficient as the one adopted. In referring to the gates for the locks, he also stated that 92 gates were under construction at one time—the means adopted for making the gates water-tight had proved very efficient. Mr. Goldmark dealt at length with the slides, and told of the millions of feet of soil which had also been forced up from the bottom of the canal. The risk, however, of slides was now getting less. The government provided free quarters, light, coal, and wood for the employees, and, said the speaker, they had to stop building married quarters owing to the expense, with the result that a man had sometimes to wait a year and a half before he could get married. Men of twenty-two nationalities were engaged in constructing the canal, and this entailed different cooking for every nationality. The negroes formed the bulk of the workers, while the Spaniards were the most intelligent.

A brief discussion followed, in which Messrs. A. D. Swan, Julian C. Smith, and C. R. Coutlee—all of whom have visited the canal—and others took part. The speakers agreed with the chairman, Mr. J. M. Robertson, that the address had not only been informative, but had proved of more than passing interest.

At the conclusion of the speeches Mr. R. A. Ross presented the Gzowski medals awarded to Messrs. Julian C. Smith, R. M. Wilson, and Henry Holgate for their papers on the Cedars Rapids development.

Expenditures for Harbor Work at St. John, N. B.

In his annual report for the year 1916, Mr. Wm. Murdoch, city engineer of St. John, N.B., describes repair work on the harbor wharves and gives a statement of expenditures. In connection with South Rodney wharf, the total expense, including both operation and maintenance work, amounted to $31,274.07. Of this sum, $2,825.44 was expended for track repairs, 517 new ties being placed, stringers renewed in some places and new props put up where settlement had occurred. There was also $1,550 required for fenders and platform repairs. Considerable repair work was also carried out on the Union wharf, the most important of the city's wharf properties. Forty-eight new piles were driven, averaging about 35 feet in length; 51 new caps placed; seven bents cut off at ground level and new forms built upon the remainders of the piles; 246 new stringer members averaging fully 12 feet in length, and 632 new ties laid; 320 new braces placed transversely and longitudinally, being secured to piles with screw bolts and nuts; trackmen's walks renewed; three bumpers repaired. The cost of this particular work amounted to $6,771.42, while the entire expense in connection with the wharf totalled $59,632.95. As the trestles are likely to continue causing considerable annual outlays, Mr. Murdoch recommended that they be done away with by filling with ballast and building up to the track level. The expenditure required in connection with the old crib structure, known as the C. P. R. wharf, amounted to $1,864.39. Other items were: $1,704.42 for dock fencing at Sand Point and miscellaneous work, requested by the military authorities; operation of hoisting scow, $410.65; expenses, such as office rents, salaries, etc., $9,236.54. Mr. Murdoch also made a suggestion regarding the locating of a dock in the upper part of the harbor. The site recommended, he said, was highly desirable, being well in from storms, entirely free from ice and strong currents, and affording 3,800 lineal feet of wharf front, centrally situated on the line of the proposed harbor bridge. Borings had shown that such a wharf could have 35 feet in depth of water along the entire front suggested, without excavating rock.

The International Clay Products Bureau, Kansas City, Mo., have just issued a booklet entitled "The Clay Pipe Book." This publication deals fully and exclusively with vitrified clay pipe and drain tile Copies may be obtained on request to the Bureau.

New Town Hall at Orillia

THE rebuilding of the town hall at Orillia, Ont., has just recently been completed at a cost of some $71,000. This new hall replaces an old building, erected about twenty years ago, which had been gutted by fire. It is a handsome brick structure, with Indiana stone trimmings, situated in the centre of the town and surrounded by ample grounds which set it off to advantage. The hall contains not only the municipal offices, but also a large auditorium which is to be used as a theatre. In the reconstruction of the building the side walls of the old structure were retained and extensions added at the front and rear. The dimensions are 144 ft. long by 60 ft. wide and the height to the top of the roof is about 65 ft.

On the ground floor of the hall, there is the entrance vestibule, an extension from the old building, finished with a vaulted cement ceiling. Then there is the main lobby, which contains the fireproof staircase leading to the auditorium on the second floor, and gives access to the main corridor approaching the council chamber. Flanking it are two circular towers. The council chamber is 40 ft. x 30 ft. in dimensions and accommodates 150 people. Off this chamber are the police offices and councillors' retiring rooms. These in turn are approached from the south side through a square entrance tower, which also contains an exit from the auditorium above. At the rear of the building are the market and rest rooms.

The second floor of the building is given over to the auditorium, which is of fireproof construction and fitted out to meet theatrical requirements. The stage gives accommodation that is surpassed only by that afforded by the largest city theatres. The balcony is built on the cantilever plan and there are only two pillars, which are located at the back of the house, and do not form an obstruction, so that there is a clear view of the stage from all the seats in the theatre. The ceiling is of segmented panelling and the proscenium arch is surrounded by an enriched decorated plaster ornament. The theatre is also used for motion picture display. The operating room for the projector is fireproof in itself, the floors, walls and ceiling, being of reinforced concrete and protected by fire doors. Access to the balcony is provided by staircases contained in the two circular towers which flank the main lobby. Theatrical equipment can be elevated to the stage by means of an elevator at the rear of the building. The auditorium has accommodation for 1,000 people and has nine exits, including the entrance. It is lighted by two large semi-indirect electric fixtures, about 4 ft. 6 ins. in diameter, specially designed features in staff plaster.

The erection of the town hall was superintended for the council by Mr. Bennett, of Orillia. The rough carpentry, concrete work and masonry was carried out by day labor and the balance of the work by contract. McGregor & McIntyre, Toronto, had the contract for the steel work; also the ornamental iron stairs and steel fittings for the stage. Other contracts were awarded as follows:—Harry Alexander, Inc., Toronto, electrical work; A. Matthews & Co., Toronto, galvanized iron and roofing work, also fire door work; J. R. Eaton & Sons, Orillia, interior woodwork; E. Latimer, Orillia, plumbing and heating; W. H. Price, Orillia, stone work; elevator, Otis-Fensom Co., Toronto. The James Morrison Brass Co., Toronto, supplied the electric light fixtures, and the Canadian Allis-Chalmers Co., Toronto, brass railings and curtain equipment.

The building was designed by Messrs. Burke, Horwood and White, Toronto.

A Peterboro Factory

For the Manufacture of Dairy Machinery—Description of Buildings and Equipment—15 Acres of Ground Area

THE plant of the De Laval Company, Ltd., Peterboro, Ont., consists of (a) the creamery and milk plant machinery factory building, which is 585 ft. long by 110 ft. wide; (b) the finished goods warehouse and shipping department, which is a two-storey building, approximately 220 ft. by 110 ft., with mezzanines; and (c) the cream separator part of the factory, which is approximately 220 ft. by 110 ft.

These three buildings are joined together by a well-designed wall and covered walk, with a large ornamental iron gate on each side of the office building at the entrance to the factory yards.

The separator factory and creamery machinery factory are one-storey, saw-tooth roof construction, with a north light. Five inches of tar concrete was used as a floor base, on top of which were laid 3-in. planks, and then on top of these the hardwood maple flooring. The buildings themselves are of concrete base and concrete walls up to the windowsills, with a water-table running all around at that height. The walls from the concrete up are of light-colored brick, capped at the top by tile covering. The roofs are of Johns Manville construction. All trusses and pillars are of

Factories of the De Laval Company, Limited, at Peterboro, Ontario steel. The plant is equipped with fire doors, with fusible links throughout, and is sprinkler equipped, making it absolutely fireproof, or as near as it is possible to be. All pipes, wires, etc., of any nature whatever are run from one building to the other through a concrete tunnel about four feet square, which runs down one side of each building and across under the walk, so that no digging or trouble of any kind is experienced when it is necessary to connect with the pipes or wires or make repairs.

The roof on the finished goods warehouse is of a monitor type. Alongside of this warehouse is a depressed track, into which each day the cars are switched for unloading or loading of goods belonging in that department.

A tinning room of wood structure, sprinklered and otherwise protected, is provided between the finished goods warehouse and the separator factory, wherein all of the tinning required in the company's manufactures is accomplished.

Concrete walks connect the unloading concourse alongside the depressed track with the separator factory rough stores.

On each side of the large iron gates are provided hose houses, with approximately 1,000 ft. of regular underwriters' fire hose, interchangeable with Peterboro city hose. Fire hydrants are planted throughout the yards, and a 1,000-gallon-per-minute fire-pump has been installed in a room of its own next to the boiler-rooms. This is under steam continually, and is connected with a covered cistern, which holds 150,000 gallons of water, so that if at any time there might be no pressure on the city mains the plant would be protected on account of its own unit.

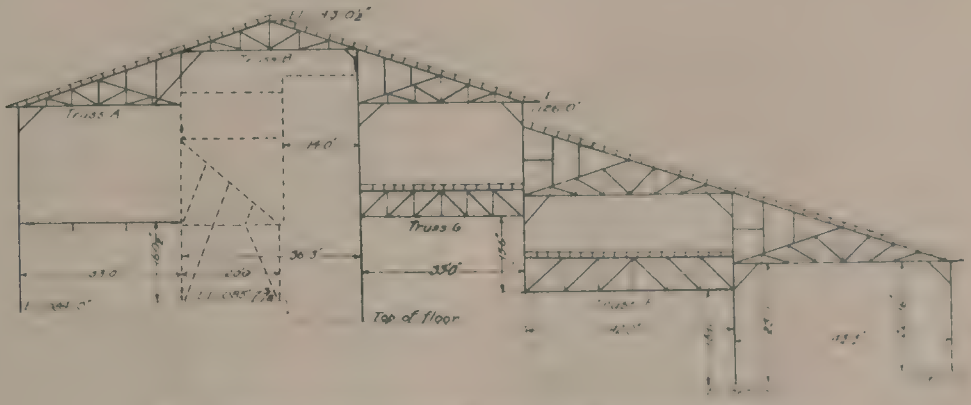


Fig. 1—Section of timber frame stamp-mill building at Hollinger gold mines

The company has over a half-mile of railroad switches on its property, one being the depressed track above referred to, Track No. 2, which runs up and along the hardwood lumber sheds and creamery factory building, and Track No. 1, which runs up along the loading concourse on the silo department side of the factory.

The boiler-room contains two 125 h.p. boilers, with the usual assortment of condensers, pumps, etc., and a Westinghouse high-speed engine. Most of the power required in the factory is hydro.

The company's line of manufactures includes De Laval cream separators, Alpha milk and cream pasteurizers, creamery and dairy churns, and other machinery, vats of all sorts, bottle fillers, bottle washers, and, in fact, anything that may be thought of in connection with the handling of milk. Also Ideal green feed silos. The ground area is 15 acres.

Gold Mine Buildings

At Timmins Ont. -Timber Frame Construction Designed to Accommodate Specialized Metallurgical Machinery

THE drawings in Figs. 1 and 2 illustrate types of mill building design in use on the property of the Hollinger Consolidated Gold Mines, Ltd., at Timmins, Ont. The buildings were constructed last year. Fig. 1 is a cross-section of timber frame stamp mill building, these bents illustrated being built on 14 ft. centres. The bents are of timber framing, with 10 x 10 in. posts and trusses of 8 x 8 or 8 x 10 timbers. The intermediate flat trusses G and F support concentrating tables, while heavy machinery and tanks are installed below on concrete foundations built up from grade. A large timber ore bin runs the entire length of the building, shown in dotted lines, the roof trusses A and B being each half supported on this bin.

The bin is constructed entirely of British Columbia fir, with cast iron bearing caps used at the joints where necessary to reduce the- compression across grain of timbers to a maximum of 250 pounds per square inch. The bin has a capacity of 16 tons of ore per foot run of length, and is 200 feet long. Cast iron bearing caps are also used in the building construction where necessary to prevent crushing of timber.

Siding and Roofing

The building is sheeted with a double layer of 1 in. rough lumber on 2 x 6 studs, spaced 24 in. apart, with tar paper between layers, and covered with No. 26 gauge galvanized iron, with a layer of building paper beneath. The roof is constructed in the same manner, on 2 x 8 purlins. This method of sheeting and roofing gives adequate insulation during the extreme winter conditions without excessive heating cost.

Fig. 2 shows the typical cross-section of the tank-house, the upper section showing trusses over tanks, these bents being in pairs, with rows of columns between tanks as in the lower section. This type of building was developed to house tanks 40 ft. in diameter by 15 ft. 6 in. deep, provide support for the mechanical rakes operating in the tanks, and at the same time reduce waste space and consequent cost of heating to a minimum.

Truss Loading

In addition to the usual dead and snow load, each pair of trusses spanning a tank may be called on to carry an additional load of 5,000 pounds each on two lower chord panel points, when the mechanical rakes supported on them are lifted.

The tanks are built at elevations differing by 2 ft. 6 in. each for metallurgical reasons, and this factor determined the slope of room. The depth of truss was fixed primarily to permit headroom for the operating platforms, runways, and the necessary mechanical transmission for operating the rakes in the tanks.

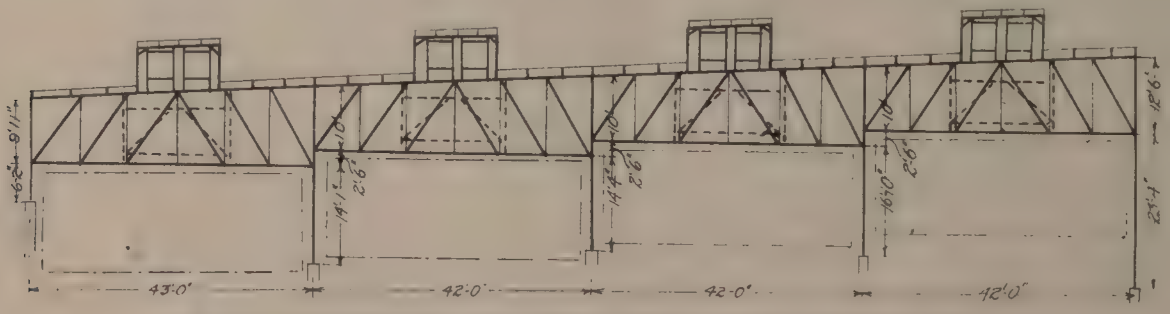


Fig. 2 (a)—Cross section of tank house, Hollinger gold mines; trusses are used above tanks.

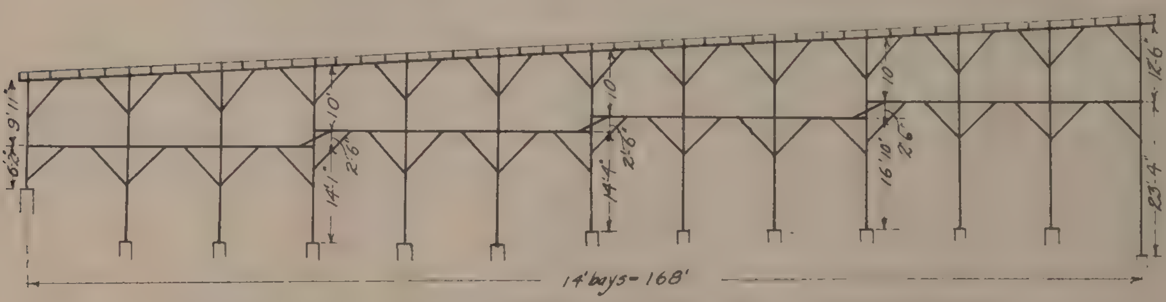


Fig. 2 (b)—Cross section of tank house, Hollinger gold mines; columns are located between tanks.

The buildings are lighted by two windows on each side of the square monitors on the roof over each tank, which gives light just where required. The monitors also provide necessary additional headroom for lifting the mechanical rakes.

The building is covered with a Barrett Specification roof, laid on 1½ in. T. and G. planks. The purlins are 4 in. x 10 in., spaced about 3 ft. 6 in. At the present time the building contains 32 tanks, each 40 ft. in diameter.

Both buildings described above are fitted with automatic wet pipe sprinkler system throughout.

Added Features at Good Roads Congress, April 10-14

The fourth Canadian and International Good Roads Congress will be opened by His Excellency the Governor-General in the Horticultural Building, Lansdowne Park, Ottawa, on April 10, at 2.30 p.m. Several important additions have been made to the programme. Alex. Fraser, of the Quebec Department of Highways, will read a paper on "The Correction of Alignments and Grades in Existing Highways." T. Linsey Crossley, of Toronto, will deal with "Asphalt Pavements," and C. A. Mullen, of Montreal, will have a paper on "Specifications and Contracts for Pavements."

Engineers' Interest

The Canadian Society of Civil Engineers is taking an unusual interest in the forthcoming congress. Its president, J. S. Dennis, assistant to the president of the Canadian Pacific Railway, has personally accepted an invitation to be present, and has been instrumental in having forwarded an invitation to each member of the society's council and to the secretaries of the Ottawa and Toronto branches of the society. The Rotary Club of Ottawa has requested the Dominion Good Roads Association to provide a speaker to give an address on good roads at the club's luncheon, scheduled for the opening day of the congress. The Ottawa-Prescott Highway Association will exhibit at the congress some miniature reproductions of model roads, with others that are not models of what roads should be.

Granite and Marble Dealers' Officers

The following officers were elected at a convention of the Granite and Marble Dealers' Association of the Province of Quebec held in Montreal: President, Jas. Brunet, Cote des Neiges; 1st vice-president, Jas. Norris, M.P., Aubrey; 2nd vice-president, A. L. Smith, Montreal; secretary and treasurer, Jos. Murphy, Montreal; Sergt.-at-Arms, G. E. Tremblay; and Chairman of District Committee, H. S. MacLeod. It was decided to take measures to organize the trade in other provinces now without such branches and to endeavor to get quarry men, manufacturers and retail dealers to work in closer relations. A mid-summer meeting will be held in Quebec and the next convention in Montreal.

C.S.C.E. Organizing a Technical Branch for Students

The Council of the Canadian Society of Civil Engineers have decided to organize a technical branch in connection with the students to deal with matters of interest to that section. The secretary, Mr. Fraser S. Keith, has been requested to work out the details of a scheme.

A serious shortage of pulpwood in Canada during the present year was predicted recently by J. A. Bothwell, of the Brompton Pulp and Paper Company, and chairman of the Mechanical Pulp & Paper Association.

Derrick Fails from Dry Rot

Recent Serious Accident to Wooden Derrick Draws Attention to This Danger Outside Appears Sound

FREQUENT accidents to hoisting rigs show that derricks and other erection apparatus should be given more attention by their designers and by the contractors and inspectors. The various parts should be strong enough to resist any probable combination of stresses that may come upon them in different positions with a reasonable factor of safety, and the timbers and cables should be carefully examined before use on each piece of work and at other regular intervals to see that they are in safe condition. Derrick timbers should not be left exposed to the weather for long periods when not in use; they are almost certain to be attacked by dry rot. Painting the outside may hasten and not prevent this. The danger of dry rot is well illustrated in a fatal derrick failure recently occasioned in connection with the erection of a public building is Portland. The boom of a stiff-leg derrick broke near the upper end and dropped a roof truss to the street. Two steel workers were riding to the roof on the truss; one fell with it and was killed; the other jumped or was shaken off inside the building and escaped serious injury. Three roof trusses besides the one that dropped and several roof beams were damaged. The top of the wall was crushed for a short distance, and a section of scaffolding was destroyed. Broken pieces of wood from the end of the boom were found to be seriously affected by dry rot, although the outside appeared to be sound.

Boom Appeared to Be Sound

The derrick consisted of two stiff legs placed at right angles to each other, a mast approximately 30 ft. high, and a boom with a reach of 90 ft. The main boom was 70 ft. long and 15 in. or 16 in. in diameter at the larger end. It was spliced out to a length of 90 ft. by lapping another round timber about 40 ft. along the under side and lashing the two together with wire rope at the ends and centre of lap. The contractor stated that this timber was five years old, and that it had been stored in their open yard when not in use, where it was exposed to the weather. When new it had been given a coat of linseed oil and one of green paint. He thought that an outside examination would not have indicated unsoundness, and that the steel workers would not have ridden on the truss if they had considered it unsafe.

There were two lifting blocks—one at the end of the main boom and one at the end of the spliced length. They had a four-part steel cable, and the same line ran through both, so that the strain was divided about proportionately between them. The hoisting line ran from the lower hoisting block to a sheave close to the end of the boom, followed the top of the boom to the mast, and passed down through the turning pivot to the engine, which was located on the main floor of the auditorium.

Details of Boom

The boom was 10½ in. in diameter at the tip; it had a vertical slot 2 in. wide and 13 in. long for the hoisting line sheave, a collar formed of two pieces of 1 in. x 6 in. metal with 1¼ in. bolts and heavy shackles for the hoisting and boom raising blocks. There was a ½ in. x 4 in. strap on each side hooked around the outer edge of the collar and extending back about 3 ft. Four ¾ in. bolts and an 1¼ sheave pin ran through both straps and the timber. There was an old horizontal check extending from the tip to a point beyond the inner bolt, and an old vertical crack running both ways from the sheave slot, which divided the end of the stick into four parts. There was also quite a large sound knot near the end. The break that caused the accident was close to the inner ¾ in. bolt.

The accident occurred when the derrick was lifting a 5,100 pound truss. The truss had been lifted some distance above a wall, 60 ft. high, and roof framing, and turned at right angles to the wall. The boom was at an angle of nearly 45 degrees. Two or three sharp reports like rifle shots were heard by bystanders a few seconds before the truss reached this position. They appeared to come from the end of the boom. The end suddenly snapped off three feet from the tip, the truss dropped on the outer roof beam, slipped down across the wall, and fell to the street, carrying away the scaffolding as it fell. The blocks and cable went with it, and some cable was reeled from the drum of the engine. The boom immediately dropped to the roof, striking transversely another boom that was lying over a truss, swung violently downward, and split two or three large pieces from the end, one or two of which fell to the ground. Some electric wires on poles nearly as high as the wall were broken by the falling truss. The current was conducted to the roof steel, and several workmen in contact with it received shocks. The 10 in. beam that was struck by the truss was sheared off diagonally through the web at that end.

Dry Rot Sapped 75 Per Cent. of Strength

An examination of the broken timber showed that it was so affected by dry rot near the end that probably not 25 per cent. of the strength remained. Fungus growth was present in some of the splits. There was a thin shell of quite sound wood outside. Its condition could have been determined by boring a few holes in it, or probably by percussion. It had very likely been strained to the breaking point by some previous load. The shape of the end connection and the fact that the spliced piece was not in line with the main boom would cause considerable eccentric stress when the boom was in its lower positions. The brake on the engine may have slipped and produced a shock on the cable; it was seen to slip a day or two later.

Steel erectors should, as far as possible, keep the workmen from riding on loads, and they should be made more responsible by law for the proper construction, care, and inspection of derricks and other erection equipment. This is not limited to steel structures, but applies to those of other materials. Scaffolds on frame buildings are often built insecurely and sometimes cause accidents. Probably most accidents could be prevented by a little care and forethought. But it has generally been the practice to give consistent attention to the design and superintendence of permanent buildings, and none to the temporary structures used in their construction. It is not right to entirely slight the latter.

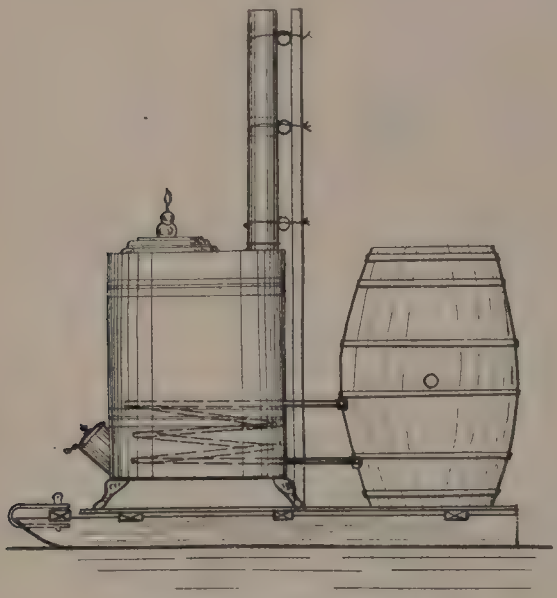
Spontaneous ignition of wood, according to a paper read by Frederick J. Hoxie at the annual meeting of the American Society of Mechanical Engineers, is undoubtedly intimately associated with spontaneous ignition of charcoal. In dwellings and factories many of the fires originate in the woodwork near steampipes or other heating appliances which are kept at temperatures far below the ignition point of wood and are the result of spontaneous ignition of charcoal formed by slow combustion over extended periods of time.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Portable Water Heater Made from Old Stove and Barrel

A portable water heater used very successfully in building small concrete structures for irrigation canals is shown in the sketch, taken from Engineering Record. As the structures averaged between 6 and 10 cubic yards of concrete each, it was necessary to have some means of heating the water that could be moved easily and quickly.



Portable water heater mounted on sled.

The heater built consists of a common sheet-iron heating stove, inside which was fitted a coil of 1-inch black iron pipe with three turns, the ends of which were fastened into the sides of the water barrel with lock nuts. The stove and barrel were wired securely to a stoneboat. When the concrete mixer was moved from place to place the heater was pulled along behind with ease.

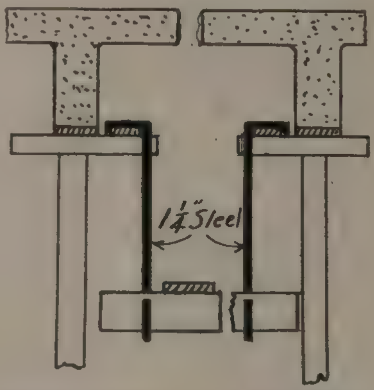
A similar arrangement was also used for heating water in making concrete pipe in an enclosure during winter months. The cost of securing hot water with this rig was reduced to a minimum by using scrap pieces of form lumber.

Soot Dislodged from Stacks by Gun

A gun, made by drilling a hole in the centre of a piece of shafting, and loaded with blasting powder, tamped with dry clay and fired by fuse, can be used to clean the soot from any type of stack or chimney without injuring it. In describing this method, the Du Pont Magazine suggests that to make such a cannon of convenient size a hole 1¾ in. in diameter may be drilled 10 in. into one end of a 14-in. piece of 4-in. shafting. A small touch-hole should be drilled into the side of the large hole near its lower end. The proper charge consists of FFF blasting powder poured into the large hole to within 2 in. of the top and tamped with dry clay. The cannon is fired by a short piece of fuse. This charge is sufficient for a stack 100 ft. high, although the number of shots necessary to clean a stack thoroughly depends on its condition as well as on its size. Ordinarily three or four shots will suffice. It is stated that one of the largest manufacturing companies in this country has used this method for several years in its industrial plants without accident or injury to any of its stacks.

Scaffolding for Removing Forms

The removal of forms of high buildings call for some kind of scaffolding that can be handled rapidly. A type used on a recent job is illustrated in "Concrete," and the adoption of this idea may prove useful in many places. As indicated, hooks of 1¼-in. steel were made and hung over a plank supported on the shore heads. They carried a plank on edge, over which the flooring was laid, which formed a scaffold for easily removing forms.



Scaffold to remove forms of high buildings.

New Asphalt Repair Wagon

To meet the demand for an asphalt repair outfit of low cost and available for the use of municipalities where no asphalt plants are located, the Iroquois works of the Barber-Asphalt Paving Company has devised an asphalt repair wagon capable of supplying material for from 50 to 75 square yards of patching per day. The total weight of the outfit is only two tons. It can be used to remelt old asphalt paving or cakes of new mixture made at a larger plant and stored; for heating sand and stone with asphalt cement to make new mixtures, and as a sand, gravel or stone drier or substitute for a melting kettle. The wagon is supplied with a full outfit of paving tools.

Large Order for Concrete Mixers to be Used on the Winnipeg Aqueduct

THE London Concrete Machinery Company recently secured the contract for nine more concrete mixers to be shipped on April 1st for use on the Winnipeg Aqueduct. Three of these are one cubic yard batch mixers for the Winnipeg Aqueduct Construction Company and six are three-quarter yard batch mixers for Thomas Kelly & Sons. It is interesting to note the important part that machines manufactured by this company have taken in the building of the Winnipeg aqueduct, the largest concrete work ever attempted in Canada. This work was commenced two years ago. The Winnipeg Aqueduct Construction Company (which is an amalgamation of the Carter-Halls-Aldinger Co. and the Northern Construction Company, organized for the purpose of taking a section of this work), called for tenders for concrete mixers. For this work they required a machine of a capacity of three-quarter yard per batch, the machine to be constructed so that it could be mounted on trestle work about 20 feet high, with charging apparatus to lift the materials from the ground level, the machines all being set on this trestle work to admit of the concrete being loaded into dump cars which would be hauled in trains of fifty cars by dinkey locomotive, thus depositing the concrete in the forms within a distance of one-half mile. These machines being subject to hard usage required a very strong construction in order to stand the severe strain which would be placed upon them; many of the trestles supporting these mixers were built on muskeg, it being impossible to get a solid foundation for their support.

Tenders were called for the supplying of the first six machines to be delivered in April, 1914, and after a thorough investigation the Winnipeg Aqueduct Construction Company placed their order for these machines with the London Concrete Machinery Company. After using the machines for one year continuously, and having secured a contract for another section of the work, the company ordered two one cubic yard batch mixers which were delivered in April, 1916, making eight London mixers then in use on this job. At the end of the year 1916, after having secured other portions of the contract, this company purchased three more one cubic yard batch mixers of the same type to be shipped April 1st this year.

The balance of the contract for the Winnipeg aqueduct has recently been let to Thomas Kelly & Sons, of Winnipeg, who recently placed their order for six London three-quarter yard mixers to be shipped on April 1st of this year. This makes seventeen concrete mixers supplied by the London Concrete Machinery Company on this job, totalling in price about $30,000. In addition to this they supplied a large number of power operated pumps and other equipment. The above purchases not only speak well for the quality and efficiency of the London mixers but they also indicate that western contractors are doing their share to patronize Canadian industries. It is needless to say that Canadian manufacturers of machinery do not take second place when compared with similar industries in any other country.

Mr. Henry Timmis spoke on "A Rational Tax System" at a luncheon of the Montreal Builders' Exchange on March 29. He advocated the single tax system, claiming that a tax on land values was the only logical tax, and that the Canadian cities which had tried it were satisfied with the results. Moreover, it was conducive to increased building operations, one outcome being a marked gain in the proportion of people owning their own houses.

Addition to Factory of Electrical Concern

In preparation for the prosperous times which the company anticipates will prevail after the close of the war, the Standard Underground Cable Company of Canada, Limited, is making an addition to its factory at Hamilton, Ont., which, when completed and equipped with the necessary machinery will represent an investment of $50,000. The illustration shows in the foreground this addition with a portion of the former factory in the background to the right, the new part extending about to the point where the car is to be seen standing on the switch. The new structure consists of one storey, with basement built, built of brick and concrete, and is 125 by 120 feet in dimensions, which gives a total increase in floor space of 30,000 square feet. It is most modern in type and equipped to secure the lighting, heating, and ventilation necessary to the best working conditions. Ample fire protection apparatus is also provided for, which includes a complete automatic sprinkler system. The architects are Prack & Perrine, of Hamilton.

The new building will be devoted exclusively to the uses of the wire-drawing department, and, in addition to housing the former equipment, will contain material additions of new machinery of the latest design capable of drawing wires ranging in size from No. 40 B. and S. gauge, which is about the thickness of a hair, to the largest size of trolley wire; also machines for grooving trolley wire and for rolling flats and squares such as are used in the manufacture of magnet wire. There will also be two new "Bright-annealing" furnaces for annealing or softening the wire after it has been drawn. This addition will not only give room for a considerable increase in the output of the wire-drawing department, but the space released will allow for expansions in the stranding and cabling departments.

Addition to factory of Standard Underground Cable Co.

All of the machinery in the new plant will be electrically operated by three-phase alternating current motors of 550 volts, 25 cycles, the current being furnished by the Hamilton Hydro-Electric Department and carried from the overhead transmission lines to the transformers on the company's property by underground cables. Power is now taken for other uses in the plant from the Dominion Power and Transmission Company.

This increase in the manufacturing capacity of a plant erected just six years ago and still modern and highly efficient, considered in connection with the excellent rail and water shipping facilities afforded by its being located on two great railway trunk lines and on the shore of Lake Ontario puts the Standard company in a splendid position to meet promptly the electric wire and cable requirements of its customers; both domestic and foreign.

Mainly Constructional

East and West—From Coast to Coast

The Vancouver Engineering Works, Limited, has been incorporated, with a capital of one million dollars, head office, Vancouver.

The Toronto city council have passed a recommendation for a new 42-foot granite block pavement on Cherry Street, at a cost of $41,346.

J. F. Hewitson has been awarded the contract for the construction of buildings for the Port Arthur Pulp and Paper Company plant at Port Arthur, Ont., at $350,000.

Akerberg, Thomson and Company, Limited, have been incorporated with a capital of $45,000, head office, Prince Rupert, B.C., and will carry on a general engineering business.

There has been a substantial increase during the past year in the output of antimony ore, limestone and gypsum in the province of Nova Scotia, and a revival in the production of manganese and scheelite ores.

A. A. Scully, Limited, has been incorporated with a capital of $40.000, head office, Toronto. The firm will deal in railway, industrial and contractors' equipment and supplies, and also carry on a general contracting business.

Building permits to the value of $410.281 were issued in the city of Toronto during the month of March this year, as compared with a total of $272,690 in March, 1916. The number of permits issued for these months was 320 and 192, respectively.

The Toronto-Hamilton Highway Commission's proposal to widen the Lakeshore Road section of the highway at the western limits of the city, involving an addition of about $100,000 to the city's share of the expenditure, has been referred back by the Toronto city council.

The scheme drawn up by Mr. A. D. Swan, of Montreal, for the development of Vancouver harbor has been approved by the Harbour Commissioners. Some necessary land, concerning which there were arbitration proceedings, has been acquired. Particulars of the scheme appeared in our issue of December 20.

Building returns continue to give a very good showing for the trade in Welland, Ont. During March permits were issued to a value of $31.115, as compared with $5,045 in the same month last year. The total for the three months of the year is $41,830, while for the corresponding period last year the total was $10,038.

In the city of London, Ont., 58 building permits were issued for the month of March, at a value of $46,300, as compared with 50 in the same month last year, valued at $40,220. For the first three months of the year the total is $79.040, the permits numbering 95. This compares with 74 permits in the corresponding period in 1916, valued at $78,215.

With a view to establishing an aviation school on the Delta, agents of the Dominion Government are reported to have taken an option on the Benson property at Boundary Bay, near Ladner, B.C., about two and a half miles from the international boundary. The estate has an area of about 700 acres, all quite level, and has a frontage of half a mile on the bay.

A deputation representing the cities of Kitchener and Guelph and the township of Waterloo will take up the matter of the proposed Guelph-Kitchener Radial Railway with the Hydro-electric Commission of Ontario, in order to obtain their sanction regarding the route via Bloomingdale, New Germany and Bridgeport, which is endorsed by the councils which the deputation represents.

The building trade in Windsor, Ont., seems to have got off to a good start this season. Homes are going up at a rapid rate on the west side, and many are being sold or rented before they are completed. About twenty houses are being built by Peter Osterhout, and Baby Bros. have started eight of twenty-one planned. The firm of Winter, Williamson & Little is engaged in completing a row of apartment houses on Cameron Street, the erection of 21 houses on Elm, 4 bungalows on Josephine, 11 dwellings on Pelissier, one on Pierre, and one on Moy Street. Plans are also being prepared by Mr. Gilbert Jacques for two new industrial buildings—a service building for the Studebaker Corporation and an addition to the plant of the Canadian Lamp & Stamping Company. The former will be a three-storey structure, of brick, steel and concrete, 50 by 80 feet, costing some $30,000. The latter will be a one-storey building, 60 by 210 feet, of brick and steel construction, which will be erected at a cost of about $25.000.

A meeting of the Engineers' Club of Peterboro, Ont., was recently held in the Oriental Hotel in that city. The business of perfecting the organization was taken up, the meeting being opened with a discussion on the proposed constitution of the club, which, after some suggestions, was referred to the executive for further consideration. It was decided that the regular meetings would be held on the second Thursday of each month, September to May, inclusive, and that the present officers would hold their positions till May, 1918. The following three committees were appointed: Membership, meetings and papers, and entertainment. The paper of the evening was read by Mr. A. G. Grier, of the Canadian General Electric Company, his subject being "The Status of the Engineer." The club has a membership of 35, and those instrumental in its iniation have reason to be gratified by the interest taken in it. The officers are as follows: Honorary president, R. B. Rogers; president, C. E. Canfield; vice-president, P. P. Westbye; secretary-treasurer, R. L. Dobbin; directors, G. R. Munroe, C. E. Sisson, Wm. Sangster, H. O. Fisk, R. H. Parsons.

Personal

Mr. Sydney Comber, architect, Montreal, will on April 15th remove to Room 213 Drummond Building, Montreal.

Mr. Carlton Miller has been appointed town engineer of Bridgeburg, Ont., succeeding Mr. Edwin J. Jukes, who resigned recently.

Mr. J. A. Jamieson, the well-known consulting engineer, of Montreal, was seriously injured on the night of March 29, being struck by a tramway car. He was removed to the Western Hospital. Mr. Jamieson received injuries to his head and limbs, one leg being broken, and was unconscious for three days. The latest report is that he is improving.

Obituary

Mr. Alfred Batho, a Toronto contractor, died recently in his seventieth year. Mr. Batho had been in ill health for some weeks and had undergone an operation.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 April 18, 1917 No. 16

Principal Contents

Page
Editorial ... 343
St. Croix Harbor Development ... 344
Meeting of the Council of the R. A. I. C. ... 344
Royal Engineers' Work at the Front ... 344
Progress of Good Roads in Manitoba ... 345
By M. A. Lyons
What Good Roads Mean to B. C. Farmers ... 346
By Mr. Vigor
Road Exhibits at Ottawa Congress ... 348
Canadian Woods for Structural Timbers ... 348
Fourth Canadian and International Good Roads Congress ... 349
Road Drainage and Foundations ... 350
By Geo. Hogarth
Ontario Government Assisting Road Work ... 352
By W. A. McLean
Bituminous Macadam Roads ... 355
By Wm. D. Sohier
Cement Concrete Roads and Pavements ... 357
By T. Harry Jones
Correction of Alignments and Grades ... 359
By A. Fraser
New Officers of Dominion Good Roads Association ... 361
Mixer for Concrete Highways ... 362
Mainly Constructional ... 363

Ontario's Road Legislation

A RESUME of the road laws of Ontario is pre
sented elsewhere in this issue. Sixteen year
ago, the proper and important place occupie
by the rural highway in the development
the province was recognized by the incorporation
advanced legislation in the provincial statutes. Eve
since, as experience has proven prudent and natura
progress desirable, this legislation has been revise
and re-cast until now, we believe, the provisions mad
for road development in the province of Ontario ar
surpassed by none elsewhere in Canada, and, it ca
be almost truthfully said, in the states on the othe
side of the line.

* * *

Ontario's road laws recognize the principles
local self-government which are at the root of ou
being, and which place control of our highways i
the hands of the people they serve. They further, how
ever, take cognizance of the Crown's theoretical veste
interests and rights, which allow the province to tak
over any public highway that may, in the interests
the province be deemed advisable. This makes pos
sible the establishment of a provincial highway sys
tem as provided for in the very recent enactment pre
sented at the last session of legislature and which ex
presses the keen interest that government authoritie
are taking in a problem of major importance.

Roads naturally divide themselves according to th
nature of the traffic upon them, and the laws of On
tario recognize this by making individual provision
in regard to them. By far the great majority of road
serve purely local interests. They are the by-ways
the farmers and carry little more than the traffi
created by adjoining farms. The responsibility fo
such roads is attached to the local municipal units—
the townships. The very localized nature of thes
rural roads precludes any provincial subsidized ai
but to promote a higher standard of workmanship th
province is willing to pay one-quarter of the salary
a permanent superintendent.

Early legislation recognized that certain roads radi
ating from leading market towns became especiall
singled out to carry an accumulated traffic not neces
sarily local in character. To such roads, if brough
under county jurisdiction, the province grants sub
stantial aid, 40 per cent. for construction and 20 pe
cent. for maintenance. Of the thirty-seven eligibl
counties in Ontario, twenty-five are now performin
work under this scheme, with expenditures totallin
$900,000 annually. If such county roads can be classe
as suburban to cities, the latter can make provision fo
a better class of construction by co-operating with th
county and receiving provincial assistance to the sam
extent as for a county scheme.

* * *

At this last session, legislation was presented whic
marks the most important advance ever made for roa
improvement in the province. The general provi
sions of this Act have been presented in the Contrac
Record at various times recently. In effect, a net wor
of leading highways, known as provincial highways
is to be provided for, with a government subsidy
70 per cent. This increased aid is a reimbursemen
to the counties for the more permanent and more ex
pensive type of construction that will necessarily hav
to be used to accommodate the very important throug
traffic. Responsibility for these roads will rest entirel

with the Provincial Department of Public Highways. The enactors of this law have had in mind, among other roads, a leading trans-provincial highway from Windsor to the eastern boundary, of a type of construction suited to the nature of the traffic that will find this road usable. This road, together with its branches, coupling with an admirable system of county highways, will place Ontario in an envied position.

The new Act makes further stipulation for an increased subsidy for roads designated as provincial county roads, which although not of provincial importance, carry a considerable proportion of through traffic. These roads, to which the province will subscribe 60 per cent., are to be under county control.

This legislation, as reviewed above, is evolved on a logical basis. If road work is to be performed in a satisfactory manner, cognizance must be taken of the varying nature of conditions. A road program that aims to let roads develop themselves in a haphazard, unsystematized way gets nowhere, and a scheme that aims to build all roads that are built, in a $20,000 a mile manner defeats its own purpose. The gravel road has its place as much as the concrete. Recognition of this is taken in the laws of the province of Ontario, and in so doing, the fundamentals of proper road legislation are being followed. The division of the roads into such classes as are outlined is a step in the right direction. The experience of many of the states across the line has determined that this is the only proper basis for effective road work. In pursuing this plan, Ontario is providing for a future development comparable to the best that has yet been done anywhere.

St. Croix Harbor Development

THE St. Stephen, N.B., Board of Trade, have published a report on the proposed St. Croix Harbour, prepared by Mr. A. D. Swan, M. Inst. C. E., M. Inst. M. E., on instructions by the Hon. R. Rogers. The latter promised that a scheme should be commenced, but the outbreak of war prevented this as well as other public works, being proceeded with. This naturally caused disappointment, although those interested are still hoping that an early commencement will be made with construction so that a national harbor can be developed. The instructions to Mr. Swan were to report on the suitability of the St. Croix river for a deep-water harbor which would be open all the year round for the largest class of merchant shipping. He reports that the St. Croix River is navigable for the largest class of vessels for about 25 miles in a northerly direction from Campobello Island and the Bay of Fundy. At its narrowest part between Deer Point and Dog Island, near Eastport, the river is about 2,600 feet wide, and it has an average depth at low water the whole way up to Oak Point varying from about 40 feet to 350 feet. For about eight miles of their course, vessels would pass through Passamaquoddy Bay, which is approximately about 12 miles long by 6 miles wide, and which, having deep water, would afford magnificent anchorage if desired. The river and bay are at all seasons of the year free from ice, but there is a variation in the tide of about 24 feet between high and low water. There is considerable undeveloped hydro-electric power in the vicinity of St. Stephen. The River St. Croix and Passamaquoddy Bay are comparatively well sheltered water, never closed by ice and protected from the swell of the Bay of Fundy by numerous islands near the mouth, and as there is deep water right close in shore to the sides of the river and bay, practically no dredging whatever would be necessary to form a shipping channel. Leading lights for the guidance of shipping at night would, of course, have to be provided.

Oak Point Most Suitable for Terminus

Mr. Swan recommends that, because of its geographical position as being the furthest point inland suitable for deep water navigation, Oak Point, overlooking Oak Bay, should be selected as the terminus. Oak Bay is a magnificent site, reached by a comparatively straight stretch of river nine miles further inland than St. Andrews, with ample room for swinging and excellent accommodation for the construction of terminal facilities, in addition to which there is already the town of St. Stephen a short distance off, with numerous industries, moderately large, and rapidly increasing population and varied commercial activities, affording an absolutely certain considerable amount of traffic the whole year round the moment accommodation is provided. The land at Oak Point slopes gently towards the river and bay and is all cleared, and at present under grass.

To commence with, Mr. Swan would not recommend that more than three steamship berths should be provided, say probably about 1,800 lineal feet of wharfage along the shore, having 40 feet of depth at low water; this shore wharfage could be extended as required and ultimately a number of piers could be constructed projecting out from the shore wharves into the river. The cost of the first part of the scheme would of necessity cover the railway connections for the whole and would also include the lighting and buoying of the river, etc. The cost of providing 1,800 lineal feet of concrete wharf, with sheds, mechanical equipment, lighting and railway connections and roads, but not including the cost of the site, was estimated at the date of the report at about two and a quarter million dollars.

Royal Engineers' Work at the Front

At the Montreal meeting of the Canadian Society of Civil Engineers, on April 5, moving pictures illustrative of the work of the Royal Engineers at the front were shown. These portrayed the building of pontoon and other bridges, laying of wires, bringing in German prisoners, etc. The paper on the Halifax Ocean Terminals by Mr. A. C. Brown, resident engineer, was also illustrated by a large number of moving pictures, lent by Messrs. Foley Bros., Welsh, Stewart & Farquier. The pictures gave an excellent idea of the various stages of the work, and also of the general scope of the undertaking.

Meeting of the Council of the R.A.I.C.

A meeting of the Council of the Royal Architectural Institute of Canada will be held at the Chateau Laurier, Ottawa, Ont., on Saturday, the 28th of April, 1917, at one o'clock p.m., for the consideration of very important matters, to decide where and when the Tenth General Annual Assembly will be held this year, the creation of the R.A.I.C. Medal, the celebration of the tenth anniversary, etc. It is expected that every member of the Council will be present.

Progress of Good Roads in Manitob

Bright Prospects Shown by Increasing Interest and Progressive Development — Government in Sympathy with the Movement

By M. A. Lyons*

THE "Better Roads" movement in Manitoba is developing a rapidly-increasing momentum from year to year, and, were it not for the retarding forces occasioned by the war, this movement would shortly attain such proportions as to be one of the leading features of the development of this province. Every progressive ratepayer of the country is beginning to realize the great advantages of better roads, not only to the farming community, but to the market towns and cities. At every meeting held for the consideration of the welfare of rural communities the discussion of better roads holds a prominent place. Interest in this question is fostered and developed by the different organizations throughout the province—such organizations as the Manitoba Good Roads Association, Local Good Roads Association, the Union of Municipalities, and the Manitoba Motor League.

The Government of Manitoba is heartily in sympathy with the "Better Roads" movement, and, in order to aid the progress of the construction of good roads, have placed on the statute book the Good Roads Act, which act we believe to be one of the best and one of the most liberal passed by any government. This act provides for the creation of a good roads board of three members, and of which the highway commisioner is chairman, who have charge of the administration of the provisions of the act.

The Good Roads Act is intended to apply to the construction of market roads, and in its application the municipalities desiring assistance under this act first make application to the Good Roads Board for assistance, submitting a plan showing the roads which they propose to improve. This scheme is then examined by an engineer from the department, and an estimate of cost and report made to the board. If this report is favorable, and if approved by the board, a recommendation for assistance is made to the Lieutenant-Governor-in-Council. If this recommendation is accepted by the council, the municipality is entitled to proceed with construction with the expectation of receiving aid under the act.

All work must be done under contract unless the approval of the Good Roads Board is obtained to carry it out by some other method. All contracts are let by the municipalities, subject to the approval of the board, and all work is done under the supervision of and according to the plans and specifications of the board. The scheme may be financed out of current revenue by a special tax or by issuing debentures. If done by this last method, the debenture debt is limited to 6 per cent. of the value of the last assessment of the municipality, and must receive the approval of the ratepayers. It is not necessary that the whole of a municipality come under the act, but any portion of it may avail itself of the provisions of the act.

Government assistance is given to the extent of one-third the cost of earth roads and wooden structures and one-half the cost of gravel or other better class of roads and "permanent" structures. Assistance is also given towards the cost of constructing bridges not on roads under the act, to the extent of one-third the cost of timber bridges costing not less than $5 and to the extent of one-half the cost of "permanen bridges costing not less than $200. All material use in the construction of bridges is subject to careful in spection, and the municipalities are required to have a inspector on the work during construction.

The type of road most prevalent in Manitoba is th graded earth road, although, where the material readily available, the construction of gravel roads fo the main routes of travel is rapidly gaining favo During the year 1916, under the Good Roads Act, 10 miles of road were constructed, but not gravelled, an 73 miles of road were gravelled. The total earth road constructed to date under the present act aggrega 250 miles, and gravel roads aggregate 122 miles. Ther were also constructed 23 miles of pavement, making total of 395 miles.

While the amount of construction actually carrie out has not been very large, this is due not so much lack of interest in the building of good roads, but b cause of scarcity of labor and a hesitancy on the pa of municipal officials to expend any more money o roads than is absolutely necessary during this time stress. That an ever-increasing interest is taken good roads is shown by the fact that during the yea 1916, 821 miles of road were approved by the Goo Roads Board for assistance under this act, making total of 1,310 miles aproved to date.

In the matter of culverts and bridges the munic palities are showing increasing interest in the necessit and economy of permanent structures on the ma roads. In the year just passed 79 bridges were bui under the supervision of the Good Roads Board, and these 45 were of concrete and 11 were steel on perma ent abutments. In spite of the high price of materi and labor, the season of 1917 promises to excel ev this splendid showing. Plans have already been ma for sixteen bridges of permanent type and tende called for the construction of six.

The year 1917 has given promise already of mu road building or preparation for road-building. A po tion of one municipality has voted on and carried a b law for $25,000 for their share of the cost, and is no calling for tenders for the grading of 37 miles of road Another municipality will shortly vote on a by-law f raising $55,000 as their share of the cost of the co struction of 27½ miles of road. At least two oth municipalities are strongly considering the issuing debentures, one to construct about 200 miles of ro and the other 65 miles. In addition to this, sever municipalities not hitherto active in this regard ha signified their intention to construct a considerab mileage of road from current revenue, and still othe are making enquiries in this regard.

Forward steps are also being taken in the imp matter of road maintenance. Under the Good R Act the municipality is responsible for the upkeep the roads constructed under the act, but the gover ment contributes no assistance specifically to the roads.

The municipalities up to the present time have been well organized for maintenance. Road dragging was carried out under the auspices of local good roads associations by the formation of dragging districts, in which prizes were offered for competitive road dragging. Excellent results were obtained in the districts thus formed, and in 1916 the Provincial Government offered to pay the municipalities $2.50 per mile for each mile in these competitions which was dragged continuously for the season. Government assistance to this extent was given on 358 miles of roads dragged in 1916. This year the government has offered to pay $3.25 for each mile of road properly dragged throughout the season, whether in a dragging competition or not. The municipalities are required to submit a plan of the roads which they propose to drag, to the highway commissioner before the first of May, and must also make such monthly reports as to the progress of the work as the highway commissioner may require. Report cards, forms, and record forms have been prepared by the department, and these will be supplied free to the municipalities.

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*Chief Engineer Good Roads Board, Manitoba

In addition to this assistance of $3.25, the government provides for the services of an organizer, who will assist the municipalities in organizing their dragging systems, and also a demonstrator in the proper use of the split-log drag.

A large share of the credit for the awakening of interest in road-dragging must be given to the organizations before mentioned who have so consistently urged the need for proper maintenance.

Prospects for 'better roads" in Manitoba are decidedly bright.

What Good Roads Mean to B. C. Farmers

Better Transportation Facilities the Great Need of the Province—The Good Example of Saanich Municipality

By Mr. Vigor*

ON examination of the financial reports of practically all municipalities it will be seen that the largest proportion of expenditure is made for public work, and of this important item it can be safely said that approximately 80 per cent. is spent for the maintenance and building of roads, consequently the question of good roads becomes one of vital importance to the ratepayers, both directly and indirectly, as will be seen from the following facts and figures:

First, we know that most of the British Columbia municipalities are mainly agricultural communities—that is, municipalities in which the main industry is, and always will be, the production of products derived from the cultivation of the land. These may be in the form of grain, root crops, fruit, etc., or in the form of stock and dairy produce. Now, an agricultural community, to be prosperous, requires to stimulate production, not only in a time when wheat is worth $1.50 per bushel, but all the time. The land requires to be worked. Absentee owners do no good, and in order to encourage the movement back to the land the farm has got to be made not only a popular place to live on, but a place where a man can make money. There is money to be made in farming the fertile valleys of British Columbia, and they offer a striking opportunity to the worker.

One of the most valuable and attractive assets to any farmer is transportation—access to markets. If a man can raise a bushel of wheat at a cost of 60 cents and it costs him half a dollar to get it to market, he is losing money every day on such business; whereas, if it costs him only 5 cents to get it to market, he will be on the high road to wealth, or at least a competency.

How much motor and motor car traffic is seen on the side roads of municipalities in British Columbia? Why do we not have more? It is because it costs an average of nearly eight times as much to haul the same weight over one mile of paved roads, and more than four times as much as it costs to haul it over one mile of macadam. Moreover, a horse which has no difficulty in hauling 6,000 pounds over a paved road would have a hard struggle to manage only 800 pounds over a muddy earth road. These startling figures are taken from Canadian and United States statistics, calculated on some 2,800 reports. They do not take into consideration the times when the roads are practically impassable and a farmer cannot market his crops at all.

It is a fact that at the present time and under present conditions thousands of tons of butter are being brought halfway round the world and marketed at our very doorsteps at a greater profit to the producer than local farmers can make, because of transportation drawbacks.

It may be said that it is only theory and imagination to state that bad roads are the main reasons for such a state of affairs, but it is nothing of the sort, for there are municipalities that are alive to the great value of such improvements, and it is not necessary to look far away for such examples.

On December 28, 1915, the County of Snohomish, in the State of Washington, voted a bond issue for $1,800,000 for the improvement of their county roads with hard surface, which work has been practically completed. Then the State of Oregon last year paved some seventy miles of roadway in the County of Multnomah, and are preparing this year to vote a further sum for the improvement of their roads and highways. Closer at home, we have the Municipality of Saanich, on Vancouver Island, and we will give a little attention to their case. Five years ago this district, which is located just outside of Victoria, was in the so-called happy position of having no bonded indebtedness and no improvements whatsoever. The council of this municipality is composed of as hard-headed a crowd of Scotchmen as there are in this country, careful and extra conservative, and they gloated over their financial position. Their total assessment was then about $8,000,000. What is their condition to-day? They have a bonded indebtedness of some $900,000, and more than half of that amount was used for the paving of their roadways. Now their total assessment is over $20,000,000, this increase being a potential profit to every property-owner.

Accurate estimates of last year's crop of strawberries in Saanich place the total at over $75,000, with a quarter of a million dollars' worth of other small fruits. Much of this fruit was collected and delivered at the wharf in Victoria by motor trucks at a lower cost for handling than has ever been thought possible in British Columbia, and this year, as the result of more good roads being completed, it is most likely the whole crop will be so handled. The fruit growers have got down to brass tacks, and they certainy do not fear competition from the States or anywhere else—they provide means to meet any and all competitors.

---

*Of the Columbia Bitulithic Co., Ltd., Vancouver.

As a result of the building of good roads there has been a very material increase in population, and as a direct consequence one party has invested some $300,000 in a palatial hotel located some twelve miles from Victoria, although the roads will not be completed to his place for some months yet. See what great possibilities there are for the District of Chilliwack, Fraser Valley, if the same policy is adopted! Land values, as we know, are made up of several items, and the accessibility to markets is certainly not the least. It is a fact that rents as high as $60 per acre are being paid for land on Lulu Island, and the principal reason for such figures being obtainable is a paved road connection with the city of Vancouver, which permits of transportation being possible other than by the British Columbia Electric Railway.

A bitulithic road, Saanich, B.C.

Secondly, we will consider the question of the cost of good roads as compared with the maintenance of ordinary roads in their present condition; also the financial side of this very important good roads question.

When the question comes up regarding the expenditure which has to be made for the permanent improvement of roadways, for instance, where the individual ratepayer of a municipality can see no immediate return for money expended for such public improvement, he feels like opposing a good roads campaign, especially when such sums as $75,000 to $150,000, or even more, are mentioned as the probable cost of the said improvement. He probably is staggered by the size of the figures.

However, let us consider the matter of cost and indirect return to the property-owner. Allow that a municipality is considering the improvement of its leading roads with hard surface of the very best kind obtainable, and which can be rightfully expected to last for many years to come. Such roads will, of course, cost more in the first place than the ordinary macadam roads. Let one illustrate. If a solid steel and concrete building costs you $10,000 and a wooden one, identically the same style and size, will cost only $3,000, b will require $1,500 to be spent on repairs annually. does not require much calculation to show that t $10,000 building will be far cheaper in the long ru So it is with the good roads question in all municipal ties.

We will say that your taxable assessment is abo $4,000,000. Now, allowing that your municipality we to decide to expend, say, $100,000 for the hard surfa ing of some of your trunk roads, say from 16 to 18 fe in width, it could be estimated that this amount money would pay for approximately about five mil of roadway. To Mr. Farmer this seems like a lot money, and if he has a farm which is assessed at, sa $1,000, he may not see how the proposed road improv ment would benefit him. However, the following fi ures should interest him:

We shall arbitrarily fix a maturity of twenty yea in which to pay for this five miles of road and make t rate of interest, say, 6 per cent., though undoubted the improvement will last a much greater length time than the term stated. On calculations based up the sale of municipal bonds, which would be issued f the payment of this improvement, and sold at a goo marketable figure, we find that Mr. Farmer would ha to pay about $1.50 per year on his assessment of $1,0 for the privilege of having five miles of highly in proved rooadway, which will add considerably to t value of his property and at the same time enable hi to get his produce into market over such roads at cost of 9 cents per ton per mile, in place of from 40 50 cents per ton per mile that it now costs him. H will thus save a sum sufficient to pay his entire annu tax for the construction of the five miles of roadwa every time he hauls a ton of produce over it.

Then, when we figure out this matter from t standpoint of the municipality as a whole, we find st more advantage in putting down a first-class roadwa A government road inspector of this province est mates the annual cost of upkeep of an ordinary ma adam roadway at from $1,500 to $2,000 per mile. Pe haps some particular municipality can, for vario reasons, do it for less, but we shall base our calcul tions on an average estimate of annual upkeep cost $2,000 per mile. This means, of course, to keep t macadam road in first-class shape, so that all kinds traffic may pass over it without absolutely and co pletely destroying it. So it is seen that the cost upke for five miles of roadway at this rate would be $10,0 each year, and then, when this amount is spent, it r quires the same amount each year afterwards, and st you have no permanent roadway.

The amount of interest and sinking funds to be s aside each year on a bond isue of $100,000 for twen years, at 6 per cent. interest, would be about $8.15 and the difference between this amount and $10.0 which we stated would have to be spent for mainte ance, is $1,750 saved each year, and for a period twenty years it can be easily seen that the amou saved would total enough to pay for the hard surfaci of over another mile of roadway. Also, in addition the above saving, the main feature would be that the would be no upkeep on the paved roadway for a peri of five years, as this would be guaranteed and mai tained by all road builders under either a cash or fidelity company bond, and then at the end of t twenty years the municipality has a perfectly goo paved roadway in place of the same old macadam r which would require the same continual maintena each and every year.

In such undertakings as road improvement t

Canadian municipalities are frequently aided to some extent by the governments of the province, and the government of this province is prepared to do the fair thing along these lines, but it requires the initiative of the district or municipality wishing to undertake such public improvement.

Road Exhibits at Ottawa Congress

IN point of numbers the exhibits of road machinery, supplies, etc., were not as large as those last year, due, in a measure, to the difficulty of transportation consequent on railroad embargoes. His Excellency the Governor General, prior to opening the Congress, inspected the various exhibits, under the guidance of Mr. Duchastel.

Canada Cement Co., Ltd., Montreal.—As usual, this company had a large space, and exhibited this year, in conjunction with the Trussed Concrete Steel Co. of Canada, Limited, Walkerville, the United States Steel Products, Montreal, and T. S. Kirby & Co., Ottawa. The exhibit comprised samples of road materials, and a model of a road showing the construction and method of placing reinforcement. There were two types of joints, one being an armour joint made by the Trussed Concrete Steel Co. of Canada, and the other of bituminous material. The armour plates were shown with the installing device furnished by the manufacturers. The two types of reinforcement were expanded metal produced by the Trussed Concrete Steel Co., and triangular mesh made by the U. S. Steel Products, which concern also had on view pictures of roads, illustrations showing the use of the mesh in the construction of sewers, bridges, silos, etc. T. S. Kirby & Co., as representatives of the Federal Stone and Supply Co., exhibited samples of crushed and other stone, blocks, etc.

Paterson Manufacturing Company, Ltd., Montreal and Ottawa.—A large number of illuminated views of highways were on view, together with samples of the well-known Tarvia products, Barrett's paving pitch, binders, etc.

Sawyer-Massey Company, Ltd., Hamilton.—Photos of tractors, road rollers, graders and levellers, with literature explanatory of the machines.

Canadian Fairbanks-Morse Company, Limited, Montreal.—This company occupied the largest amount of space in the exhibition. The machinery included Case road rollers and tractors for road making, and Case kerosene tractors and ploughs for farming, also oil machinery, the products of the Dominion Road Machinery Co., for making macadam roads under the penetration method. The Fairbanks Company also had on view a Wettlaufer street paving mixer of a capacity of 15 cubic feet per batch, with boom and bucket.

Imperial Oil Company, Ltd., Toronto.—Samples of paving asphalts, penetration asphalt oils, asphalt shingles for roofing.

General Supply Company of Canada.—Two street flushers, manufactured by the C. H. Vhass Co., New York, were shown by the first named concern.

Warren Bituminous Paving Co., Toronto.—Several specimens of pavement were on view. These included bitulithic, Warrenite and Bitustone, together with bitulithic for resurfacing old macadam and resurfacing old brick streets, besides bitulithic on bituminous and concrete bases.

Province of Ontario.—Some very interesting models of various roads were loaned by the province. These illustrated methods of construction and of materials employed.

Commission of Conservation, Town Planning Department, Ottawa.—This section comprised a series of photos and plans of garden sites in Great Britain, Canada, France, Australia, and Sweden. There was also a model of a Canadian bungalow and grounds.

Canadian Woods for Structural Timbers

The Forest Products Laboratories of Canada, established at Montreal by the Department of the Interior, in co-operation with McGill University, have undertaken an investigation of the woods of the different species of trees in Canada so that reliable and authoritative information may be available as to the strength, durability, and other qualities of Canadian woods and their adaptability for use in structural work and manufactures of various kinds. Such investigations have only begun at the Canadian Laboratories and the only Canadian species in regard to which fairly complete information has been obtained is Douglas fir, but as there is a special interest at the present time in regard to structural timbers, particularly in a comparison between Canadian and foreign timbers, it has been considered advisable to issue a preliminary study on structural timbers, using the information now available from many sources and particularly the results of investigations made at the laboratory of the Forest Service of the United States. This preliminary report, entitled "Canadian Woods for Structural Timbers," is now being distributed by the Department of the Interior as Bulletin No. 59. It will be found that Canadian timbers rank high for structural purposes. The results of an exhaustive series of mechanical and physical tests of Douglas fir made at the Forest Products Laboratories of Canada are now in course of publication and similar tests of other important Canadian woods are in progress, the results of which will be published as soon as they are available.

A typical macadized road in Quebec province.

Fourth Canadian and International Good Roads Congress

Reports of Proceedings and Abstracts of Papers Presented Herewith Reflect Ever-Widening Influence of the Movement for Road Development and Construction of a Permanent Value

WHILE previous Canadian and International Good Roads Congresses have received official recognition and support from some of the provincial governments, it remained for the Congress held in Ottawa from April 10 to 14 to obtain the recognition of the Governor General and the Federal Government. The fact that the gathering was held in Ottawa had no doubt something to do with this event, but it was apparent from the speeches at the formal opening on the 10th inst. that both the Government, as represented by Sir George Foster, and the Opposition, in the person of Sir Wilfrid Laurier, are keenly alive to the value of the ever-widening movement in favor of good roads. The speeches at the opening were excellent, the keynote being that, as an agricultural country, it is of the highest importance that more facilities be given to the farmers in the way of more and better roads.

Mr. J. Duchastel, the president, in welcoming His Excellency the Governor-General, alluded to the educational work of the Congress, especially in the matter of bringing home to the farmers and dwellers in small communities the urgency of proper highways and efficient construction. It had been asked why they were keeping up this movement during the war—his answer was that the work was a patriotic one, and that it was important that it should be kept alive.

Good Roads of Vital Interest to Canada

The Governor-General dealt with the subject of good roads from various angles, and drew on his experience as chairman of a British Parliamentary Committee to enforce the necessity of dealing thoroughly with such problems as they arose. He declared that the subject was of vital interest to the entire Dominion. He saw with pleasure that there were present representatives from the various parts of the country, as it was a subject which invited the co-operation of all classes. Owing to train delays, the representatives from the United States were not present; these gentlemen were always sure of a cordial welcome, but this year it would be more than usually enthusiastic. Many economic and social questions would have to be considered by the delegates at this particular period in anticipation of the ending of the war, which he hoped would not be far distant. They could only hope that the splendid deeds of Canadians in France, of which they had just received news, would be the prelude to still greater advances.

The country had passed the period when the question of the value of good roads was debated—it was now a question of construction, repair and maintenance. His Excellency referred to the subject of trackless trolleys, which had been keenly discussed in Great Britain, and suggested that this matter might well be taken up here. He also spoke, in passing, of Canada's magnificent water powers.

Sir George E. Foster followed, and spoke of his early experience in New Brunswick, mending roads. Alluding to the advance in public opinion as to the economic value of good roads, he said that the real point was to convince the farmer that he was the man who had the deepest interest in securing good roads. It was a social as well as an economic problem. The automobile had proved one of the best aids in securing good roads. On behalf of the Government he welcomed the Congress to the city. The Government were interested in having the small roads brought up to the proper standard. Hitherto the Government had spent a large amount of money on trunk roads, but they were coming to the conclusion that the most important thing was to join up the smaller highways. Sir George concluded by urging the value of good roads, well surveyed, well laid out, and properly maintained.

Sir Wilfrid Laurier spoke of the great development in Canada on the subject of good roads, and asserted that the province of Quebec had made as much progress as any in the Dominion. People were beginning to realize that the wealth of the country was in its roads, because agricultural products had little value unless they could be brought to market, and to do this good roads were necessary. He put it to them whether they would have roads cheap to construct and dear to maintain or roads dear to construct and cheap to maintain. He had spoken to Sir Lomer Gouin on this aspect of the question and told him that in his view it would have been a better policy to have constructed dearer roads rather than to have built cheap roads with higher maintenance.

Congress Promotes Entente Cordiale

Mr. W. A. McLean, Deputy Minister of Highways for the Province of Ontario, on behalf of the Dominion Good Roads Association, welcomed the delegates. He alluded to the good roads congress as part of the Bon Entente movement, binding together the east and west, and in the case of their United States confreres as a triple Entente. It was gratifying that every province had created a special department for the construction of highways, thus embodying the idea that the movement was not parochial but Dominion wide.

On behalf of the Ontario Good Roads Association. Mr. S. L. Squire, the president, also welcomed the delegates. This Congress, he said, marked a new era, in that it had received the co-operation of the State, of the two political parties, the church, and other organizations. It illustrated the democracy of the roadway, where all could meet on a common platform. He hoped the Federal Government would lend the Congress their substantial support. The press of the country had given the movement unselfish support, free from mercenary motives.

Mr. B. Michaud, Deputy Minister of Roads, Province of Quebec, traced the history of good roads in his province, and told of the measures taken by the Government to educate the people on the subject. This had been done largely through a campaign of advertising, with the result that there was a community of interest between the Government and the ratepayers. The construction of roads was as important as any other great public works. After five years of work in the province of Quebec a new public spirit had been created, which was demanding better roads.

Mr. A. A. Dion, president of the Ottawa Valley Motor Car Association, Bishop Roper, and Mr. Harold Fisher, Mayor of Ottawa, also spoke.

Road Drainage and Foundations

By George Hogarth, O.L.S., A.M. Can. Soc. C.E.*

THE stability of the entire road surface depends upon the foundation, and the strength and life of the foundation largely depends upon the facilities provided for drainage. While proper attention may be given to the drainage of the surface of the road by giving the road sufficient crown to shed the water, the great importance of subsurface drainage may be entirely overlooked. There are, therefore, surface methods of drainage and subsurface methods of drainage, and the importance of each must be realized and used to the fullest extent if we desire a permanent foundation. A sound and enduring foundation cannot be secured on subsoil saturated with water, but a good foundation can be secured by the simple means of keeping the subsoil dry. If water is not excluded from the foundation it will sooner or later destroy the road surfacing, since no road ever built could escape destruction should the foundation become yielding and soft.

Good Drainage Means a Good Road

It may be said that the whole problem of improvement and maintenance of ordinary country roads is one of drainage. Upon earth roads drainage is especially important because the material of the road surface is very susceptible to the action of water, and so more readily destroyed than are the surfaces of the better class of roads. An undrained earth road offers a splendid opportunity to the frost, and a spring thaw may result in such a road being impassable for days or weeks. A road on a wet, undrained bottom will always be troublesome and expensive to maintain, and it will be economical in the long run to go to considerable expense in making the drainage of the subsoil as perfect as possible.

There are three systems of drainage—underdrainage, side ditches, and surface drainage. Underdrainage lowers the water level in the soil and keeps it at a safe distance from the foundations. It dries the ground quickly during the spring, when otherwise a saturated condition of the soil would exist, and it also intercepts the subsurface flow of water beneath the crust of the road. Underdrainage further reduces, and will in many cases prevent, the destructive heaving effects of frost.

Particular attention to the underdrainage should be given at points on the road from 50 to 200 feet or more down grade from the top of a hill or slope, and particularly so if the roadway is in excavation. Water will usually filter out to the surface at such points, and the entire skill of the road-builder will have to be exercised in locating subdrainage to prevent heaving and cracking. In all such cases the underdrainage should not be curtailed, but rather every foot of tile that can be placed should be put in.

Blind Drains Sometimes an Advantage

Tile drains furnish the usual means for subdrainage and proper grade, and good outlet should be provided. In some cases a blind drain may be used to good advantage. The construction of a blind drain is accomplished by opening a trench several feet deep along or across the road and afterwards filling the trench with stone. The depth, distance apart, and location of such trenches will depend entirely upon the conditions encountered and the result desired.

Side ditches for all country roads are essential. Their object is to receive the water from the surface of the travelled roadway, and the grade of the ditch should be such that the water is carried rapidly to a good outlet. Such ditches also intercept and carry away water that would otherwise flow from the side hills upon the road. A depth of 2½ or 3½ feet below the crown of the roadways will usually be found sufficient. In order to be effective, ditches should have as great a grade as possible, they should be well cleaned out, and have free outlet in some creek or streams.

Surface drainage of the travelled portion of the road affects mainly the maintenance of the road, and is accomplished by giving the road or pavement surface a crown which tends to shed the water to the side ditches. The slope of the crown should be sufficient to carry the water freely and quickly to the side ditch. The proper crown to use will vary with the nature of the roadway; when a good surface is maintained a moderate rise will be found sufficient.

Present-day Traffic Requires Firm Foundations

While drainage is undoubtedly one of the first essentials of good highways, the foundation of a road is also of great importance. The foundation of a road should normally last a number of years, while the cost of maintenance should be for replacing and renewing the worn-out surface. Such conditions are difficult to obtain, since the foundation of four inches of crushed stone to-day may be entirely inadequate to-morrow under more severe traffic. The heavy loads using our highways to-day require an abundance of material in the foundation of the roads, and if our work is to be enduring we must see to it that strong and sound foundations are provided.

The fact that improved roads draw increased traffic should be given full consideration in designing a road and providing its foundation, and any traffic census made prior to reconstruction should be considerably increased in order to estimate the travel on the improved surface. In some cases it may be found that the traffic on an improved road immediately after reconstruction is ten or more times the original number of vehicles using the road, and this must be provided for.

Available Foundation Courses

The strength of the foundation of a road is greatly affected by the supporting power of the different soils and in order to obtain a road surface having a uniform resistance the thickness of the crust will need to be varied. Many kinds of foundation courses are available in the construction of roads, such as crushed stone, screened gravel, pit gravel, field stone, quarry stone, or Telford. Before placing a foundation course the subgrade should be properly rolled, in order to solidify the surface and prevent the material of the foundation being forced into the soil. This point is as important with a gravel road as it is with more permanent types of construction.

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* Chief Engineer, Ontario Department of Public Highways.

Crushed stone where used as foundation for a macadam road should be not less than six inches in thickness when compacted, and the size stone will usually be about that passing a 2½-inch ring. Screened gravel of 1 in. to 3 in. size may be used in place of crushed stone, and when placed in the road a filler containing some clay or loam should be spread in order to thoroughly consolidate the stones. Such gravel does not interlock as crushed stone does, and a thicker foundation course of gravel is therefore required.

Field stone used for a foundation may be laid in one course, from 6 in. to 12 in. in depth, and the inequalities between the stones filled with coarse gravel or crushed stone. The depth of the course should in all cases be suited to the average size of field stone available, as it is not economical to break them to a definite size. A variation of an inch or so in the size of the stone is of no consequence, since the surface stone will serve to even up all inequalities.

The Telford base may be composed of quarry stone which has been broken to size with a stone hammer. Such foundations have given good satisfaction when used, but the cost of hand-placing the stones seems to have outweighed the advantages of this type of construction.

Discussion

A long discussion followed. Mr. E. Drinkwater, of St. Lambert, P.Q., pointed out the importance of having good depth of lateral drains on suburban roads. As to suburban pavements, it was not absolutely necessary to have under-drainage if particular attention was paid to the drainage. He was of the opinion that in obtaining under-drainage money was expended without any results. With foundations built on clay there was nothing better than Telford with lateral drains, with either open drainage on the sides or tile drains with sand or gravel fill on top.

Vital Necessity for Good Drainage

Mr. L. B. Howland stated that the fundamental principle in roadway construction was good drainage.

Mr. Hogarth, alluding to the Hamilton-Toronto road, stated that the drainage there was one of the most important parts of the construction. There had been some defects in the road, and these could be attributed entirely to the drainage, the worst defects being at the slope of the hills.

Mr. W. Huber, while pointing out the great value of drainage as a means of securing substantial foundations, remarked that in certain parts of Ontario it was impracticable to get good drainage, and in such cases they endeavored to secure bottoms which would carry traffic. One method was to put in boulders, and failing these they fell back on the old method of filling up with logs.

Mr. W. A. McLean said that generally speaking he was in favor of putting in stone foundations—they must construct for the future as well as for the present. Hitherto the question of expense had been too largely a factor in determining the question of foundation. Drainage was emphatically the secret of good roads. In order to build for the future and reduce maintenance costs, wherever the earth soil was not exceptionally good, by all means put in stone foundations. Mr. McLean also insisted upon the importance of appointing experienced highway superintendents.

Foundation of Fundamental Importance

Mr. J. H. MacDonald, ex-State Highway Commissioner of Connecticut, continued the discussion and also spoke on the construction and maintenance of gravel and macadam roads. The question of drainage, he said, was a serious one. Too little thought had been given in the United States to this question, and of the 2,200,000 miles of road laid there, one-half would have to be disturbed or reconstructed by reason of the lack of forethought on this branch of construction. Three main principles were involved—one was to get the water out of the road; another was to get the water off the road, and the third to get the water away from the road—and then there was a well drained road. He was a strong advocate of the Telford base and the old English drain. Telford construction was like a well-built wall, only laid flat. It did not make any difference what the surface of the road was if they did not have any foundation. If they had only $100 to spend, lay it out on the foundation and wait until there was other money for the surface. Put in a good foundation—the surface would take care of itself ultimately. If they put in a surface only, it was waste of money, a mere make-shift. By means of such congresses the value of good roads were brought home to people in a personal sense, and thus the interest was intensified. Mr. McLean's reports were of the utmost value, and if his suggestions were carried out Canada would obtain an unequalled road system.

Finance Overrules Other Considerations

Col. W. D. Sohier, chairman of the Massachusetts Highway Commission, endorsed Mr. MacDonald's views as to the value of the Telford base, but said that in some parts of the United States it was impossible to obtain the necessary material. Col Sohier spoke of the use of corduroy roads under certain conditions, and said that while none could over-emphasize the question of drainage, one had to be guided by the question of finance and of obtaining the best foundation possible under given circumstances.

Messrs. Leonard, Fraser, Fisher, Christie, Wallis, Bray and Roberts, also spoke, the main topic being as to damages arising from drainage in relation to farms. It was mentioned that the interpretation put on the Ontario Act in Sussex was quite different to that upon it in the Ottawa district. Arising out of the discussion, Mr. Hogarth remarked that the experience of one delegate showed that a solid foundation of field stone had resulted in a satisfactory road and the absence of such a foundation had resulted in a very poor road.

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Location of Montreal-Windsor Road

At the afternoon session, Mr. Bowlby, Mayor of Brantford, submitted a resolution asking the Congress to endorse the construction of a Montreal-Windsor highway, over the central route, which would pass through Brantford. This was referred to the resolution committee.

Mr. W. A. McLean, Deputy Minister of Highways, Ontario, read a paper on "The Highway Laws of Ontario," which follows:

Ontario Government Assisting Road Work

Provincial Legislation Provides Large Subsidies to Aid Highway Development and Maintenance by the Counties—Recent Enactment Institutes a System of Provincial Roads for Through Traffic, Government Contributing 70 per ct.

By W. A. McLean *

THE road laws of Ontario are based on the excellent municipal system which grew up in the nineteenth century, and which has created excellent and progressive local self-government throughout the province. Towns, villages and cities are responsible for the up-keep of streets within their boundaries, but the care of roads in the open country constitutes one of the chief duties of township and county councils. Provision for municipal organization is made by the Municipal Act, which defines the general authority of municipal councils with respect to roads.

Local Roads Constructed at Expense of Township

Township councils, in the earlier history of the province, depended largely on statute labor for road improvement, this system having been created by the first parliament of the province (then Upper Canada) in 1796. Money expenditure, raised by general levy on the township assessment, has been steadily increasing. At the present time townships are spending annually over $1,400,000 in cash, 1,100,000 days of statute labor, having a total estimated value of $2,500,000 annually. Township councils have authority to pass by-laws to abolish statute labor. About one-quarter of the townships have done so, while the number is steadily increasing. The Highway Department is encouraging all townships to place their road expenditure in charge of a permanent road superintendent or foreman, and to this end will pay (under the Ontario Highways Act, 1915) one-quarter of the salary of such an official, the provincial grant not to exceed $150 annually.

Province Substantially Aids County Road Systems

Provincial aid to road construction is given principally through county road systems, under the Highway Improvement Act. Twenty-five counties out of thirty-seven which are eligible, are carrying on construction. Expenditure to the end of 1915 has amounted to $6,000,000, including $1,200,000 for bridges, and work is now being carried on at the rate of $900,000 annually. It is anticipated that all counties will be operating under this plan within a few years, and that the annual expenditure will be doubled. The chief features of this Act are as follows:—

A county council is authorized to assume by by-law a system of roads for construction and maintenance, the province contributing forty per cent. of the expenditure on construction and twenty per cent. of the cost of maintenance. A by-law adopting such a system may be passed by a two-thirds majority of a county council representing at least one-half of the total equalized assessment of the county.

The roads assumed are usually such as will accommodate the greater part of local market travel, creating a system of main market roads. They are the roads radiating from local market centres and shipping points, and should be connected as far as practicable to serve the needs of through traffic of the locality. The mileage of roads thus assumed by a county is usually from 12 to 18 per cent. of the total mileage of the county. The direction and superintendence of the work is placed in charge of a county engineer or capable superintendent appointed by the county council. A committee of the county council should co-operate with, advise and direct the road superintendent.

Roads are to be built in accordance with the regulations of the Department of Public Highways. The construction should be suited to local material and traffic. A standard type is regarded as a roadway well drained, graded to a width of 24 feet between ditches, with broken stone or gravel in the centre to a width of from 9 to 18 feet, and consolidated by rolling. The cost varies with local conditions, but is in general proportionate to the width and kind of metal.

The system of roads assumed, and the by-law fixing the plan of improvement, are subject to approval of the Provincial Department.

County Assumes Full Control

When roads are assumed by a county council under this Act, township councils cease to have control over them, and they should not make any expenditure on them. The county council is thereafter responsible for construction and maintenance. The provincial grant is paid annually, and is based on a statement of expenditure for the year, submitted to the Minister of Public Works and Highways by the county council, and includes all costs of labor, material, engineering services, salary of road superintendent, machinery, and bridges on the designated system of county roads. The county council may finance their work by issuing debentures for a term not exceeding thirty years, or by sums raised from year to year in the annual county rate. The cost of purchasing and reconstructing toll roads may be included in the expenditure.

The county council may by by-law make grants to towns and villages not separated from the county, for the improvement of extensions or connecting links of county roads in such towns and villages, and certain of such grants may be included in the statement of annual expenditure. Grants eligible for a provincial subsidy are those made to villages having a population of 1,500 or less, and those made to municipalities with a population of over 1,500, provided the improvement is carried out on suburban streets.

Cities Share in Cost of Suburban Roads

Provision is made under the Ontario Highways Act, that a city may co-operate with the county council in improving the leading county roads adjacent to the city, and thereby obtain a more substantial type of construction for such suburban roads. The procedure is for a county council by resolution to make application of the Lieutenant-Governor-in-Council asking that a commission be authorized to deal with the

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*Deputy Minister of Highways, Ontario.

suburban roads or portions thereof in the county system adjacent to the city and towards the construction and maintenance of which the city in question should contribute. The Department of Public Highways submits the application to the city in question and considers their views in the matter. Should the commission be recommended by the Department and authorized by Order-in-Council, it is made up of representatives chosen by the city and county council. In the case of a city having a population of less than 50,000, it would be composed of three persons, the county council selecting one member, the city selecting one, and the two agreeing upon a third. In the case of cities of over 50,000 population, the commission would be composed of five persons selected in a similar manner.

The first duty of the commission would be to determine the roads, and the length of each adjacent to the city, to which the city would contribute, the commission forming a board of arbitration for that purpose. It is then the duty of the commission to determine the work to be undertaken each year and to estimate the amounts required for construction and maintenance. The county council would first approve or amend this estimate and authorize expenditure. The county council, not later than the first day of March in each year, then notifies the city of the amounts required.

For construction the province contributes forty per cent. and the county and city each thirty per cent.; for maintenance and repair, the province contributes twenty per cent. and the county and city divide the remainder equally between them. The section of county road designated as "suburban" remains a county road for which the county is responsible; the work of construction and maintenance to be carried on under the county road superintendent but subject to the instructions of the special commission.

Establishment of Provincial Highways

A system of provincial highways has been authorized by a recent Act of the Legislature, with a view to the construction and maintenance, under the Highways Department, of a net-work of leading highways throughout the province. A highway from east to west across the province would be the main artery of such a system, with suitable connecting branches leading to other parts of the province, and joining up county towns, cities or other important terminal points.

The Act gives the Provincial Highways Department, with the approval of the Lieutenant Governor-in-Council, power to take over on behalf of the Crown, any public highway, by filing a route plan of the road in the local registry office, and giving notice in the Ontario Gazette. The Department, through its officers, is thereafter responsible for the proper construction and maintenance of the highways so assumed. For this purpose the Department has the usual powers of municipal corporations to widen or deviate the road allowance, procure material for construction, purchase machinery, and in general to control the use of the highway under the responsibilities placed upon municipalities.

Provincial Subsidy 70 Per Cent.

Adjacent to cities the cost is borne in the proportion of forty per cent. by the province, thirty per cent. by the city, and thirty per cent. by the municipality through which the road passes. Outside of the suburban section, the province assumes the proportion levied on the city, thereby paying 70 per cent., and the local municipality thirty per cent. In the case of bridges, the local municipality is placed on the same basis as in the case of a county road, viz.:—the local municipality pays sixty per cent. of the cost of a bridge suitable for county purposes, and the province pays the balance. In cases where a special type of pavement is desired by a locality, provision is made for levying any excess part of the cost on a frontage basis. Various contingencies are provided for, with, in general, a right of appeal to the Ontario Railway and Municipal Board. All cost of surveys, the purchase of machinery, plant and equipment, land for widening or deviating, general overhead and staff expeneses are to be borne entirely by the province. Thus the local municipalities will be, in effect, required to pay less than thirty per cent. of the total cost.

A fundamental basis upon which the cost is thus distributed is that each local community should be required to pay for a road suited to local requirements. It is unfair to the rest of the province to levy less than that amount. It is unfair to the local municipality to require it to pay the entire cost of a road carrying an excessive amount of through traffic. The difference between the cost of a road suited to local requirements, and one of a character suited to the traffic of a main road, is therefore to be levied upon cities immediately served, or is to be met by the province from the revenue from motor vehicles. A main road from the County of Essex to the Quebec Boundary, with branches to St. Catharines and Ottawa, passes through urban and rural municipalities having half the population of the province, and over sixty per cent. of the assessment.

Gradual Development and Extension

The building of the provincial highway system will not be undertaken as a huge work of continuous construction, but will be a matter of gradual development and extension. Wherever conditions are favorable, systematic maintenance will be applied so as to make the most of any reasonably good sections as now exist. Construction will be taken up in sections where traffic is especially heavy, or where the road has heretofore been neglected. One type of pavement throughout is not contemplated, but an effort will be made to construct in proportion to traffic, making the best possible use of local materials.

The immediate need is for a reasonably good trunk road system, joining up cities and local road systems, and making it possible for each local community to be a unit in such a trunk system without carrying an excessive or burdensome share of the cost.

Provincial County Roads

Co-operative with provincial roads, but under county control, certain roads may be designated by the Highways Department as "Provincial County Roads." To such roads the province will contribute sixty per cent. of the cost of construction, and maintenance. These roads are intended to enable the more equitable maintenance of certain county roads, carrying a considerable proportion of through traffic, but which the county may efficiently maintain, and which are not of sufficient importance to be classed as "Provincial;" or which it is not desirable or expedient for the province to assume as provincial highways. They continue to be county roads, but because of heavy through traffic, receive an increased subsidy.

Suburban roads and the assessment of cities for main road improvement is a feature of Ontario legislation, and as it is new to most parts of the province, the reasons for such requirements are of interest. The development of main highways has, in every country required the co-operation of cities. This has beeen true in the countries of Europe, such as England, France and Belgium. In the United States, the city of Detroit is paying 85 per cent. of the cost of roads in Wayne County. Cleveland is paying $800,000 annually for road construction outside of the city. In New York, the cities are paying 85 per cent. of the state expenditure. Similar conditions exist in other cities.

In the case of cities in the United States, they are, as a rule, not separated from township and county organization, so that a considerable part of their expenditure on main roads is automatically arranged. In Ontario, however, with cities separated from township and county organization, it has been necessary to devise the system of suburban road contributions provided for in the Ontario Highways Act. In order that the existing municipal organization might not be disarranged.

Enables Better Roads to be Built

Roads should be built and maintained in proportion to the traffic over them. Roads within two or three miles of a city may cost two or three times the ordinary expenditure of the county on roads, and this extra cost is difficult for the county to finance without co-operation from the city. The object of a city's contribution would not be to relieve the county of the expenditure which they are now making, or which they may equitably be called upon to make, but rather to improve the standard of roads radiating from the city, and to permit them to be maintained in a condition suited to the traffic over them. Traffic accumulates to a considerable density on the main roads immediately adjacent to the city, and it becomes an unfair charge upon rural districts to construct and maintain roads suited to such accumulated traffic. Thus the county with provincial aid may be spending for ordinary roads $5,000 per mile, made up of $3,000 from the county and $2,000 from the province. By calling upon the city to contribute equally with the county, the two provide $6,000, which entitles them to a provincial subsidy of $4,000. In this way, roads costing $10,000 per mile become possible, to the very great advantage of the cities.

Cities' Interests Not Self-Contained

Municipal boundary lines are purely arbitrary and accidental. It cannot be maintained that the true interests and obligations of cities do not extend beyond their boundaries. That city councils are inclined to think of their interests as terminating with the city boundaries is purely a traditional attitude of mind, and in considering the advantage of good main roads, is without basis of fact. Good main roads are a means of rural development and are a source of local trade, as well as a convenience to city residents. The construction of main highways radiating from a city is so clearly of advantage to the city, that artificial boundary lines must necessarily be disregarded in providing equitably for the cost.

It has been suggested that the province should contribute to the cost of continuing main roads through a city. But wealth is concentrated in cities. Cities in Ontario have an assessment of $1,033,117,544 and a population of 1,019,627; whereas townships have an assessment of $687,372,853 and a population of 1,027,220. With the comparatively small amount which cities are asked to pay to the construction of main roads radiating from them, we believe that ample consideration is given to the construction of connecting links within the city at the cost of the city. A man's farm bears a somewhat similar relation to a public highway that the streets of a city bear to the system of county roads. We aid a farmer to build roads to the boundary of his farm, but do not aid him to construct lanes and driveways on his farm. If a farm of 100 acres with a single family residing on it, and distant two miles from a county road, is taxed for the construction of such a main road, it would seem only fair that an area of 3,000 acres and containing a population of 25,000 with a valuation equal to 6,000 farms, should pay something to the cost of main roads radiating from it.

Cities Have Obligations to Farms

The building of expensive pavements within a city does not absolve the city from its obligations with respect to main roads in the open country. City pavements are not designed for traffic requirements, but are expensive largely because of the advantages of curbing and good boulevards to adjacent property, the cost being reflected in increased property values. Comparing a $4,000 per mile road in the country with a city pavement costing $60,000 per mile, under ordinary conditions of land occupation in Ontario with four farms per mile on each side of the road, the cost, if levied on a frontage basis, would be twice as great to the farmer as to the owner of a 40 foot city lot. As a matter of self-interest, due to the benefits which good roads bring to a city, it is clearly a matter in which the cities of the province should heartily cooperate with the province. There is no industry which cities can bonus with so much advantage to themselves as farming. Good roads increase the saleable produce, from the farms, all of which adds to the prosperity of the city.

Under the systems of taxation in vogue in the United States, a much larger proportion of the cost of main highways is met by the cities than is being considered in this province. The maximum rate to be levied upon a city for those main arteries is restricted to one-half mill, and the county roads to be designated as "suburban" under the Act, would necessarily be restricted to such mileage as could be adequately improved with the expenditure becoming available through the combined contributions of the city, county and province.

Cities' Contribution

The mileage of radiating roads to which each city should contribute will depend somewhat on local conditions. Consideration may be given to the local trade traffic entering the city, or to points of local interest close to the city, or to an area approximately that required to maintain the city with local farm produce. It is estimated that one square mile, as commonly farmed in Ontario, will support a population of about 300 persons, from which the radius of the supporting area may be estimated. Broadly, it would appear feasible to require the smaller cities to give proportionate support to about six miles of road for each mile of radius of supporting area; or on another basis, two miles to each million of assessment.

The Ontario Highways Act came into effect in January of last year, and there is considerable negotiation to be carried out in order to affect organization in all cases. The counties in which suburban roads have been settled are,—York, in which Toronto contributes to the entire county road system, with a special grant of $250,000 to the Toronto-Hamilton Highway; Frontenac, in which Kingston contributes to approximately sixty miles of road; Waterloo, in which Galt contributes to 25 miles, and Kitchener to 12 miles; Essex in which Walkerville has contributed to about 8 miles, and with Windsor negotiations are now in progress. Hamilton has contributed $50,000 to the Toronto-Hamilton Highway, and negotiations are in progress with the county with respect to other suburban roads.

Ontario Department of Public Highways

The road organization of Southern Ontario is vested in the Department of Public Highways, under the Minister of Public Works and Highways, and is in charge of a Deputy Minister, Chief Engineer, and staff. The duties of the Department have a considerable range, including:—The administration of the Highway Improvement and Ontario Highways Acts, which provide subsidies to county and main roads; the administration of the Motor Vehicles Act, including the issuance of permits for motor vehicles, licenses for chauffeurs, etc.; the administration of the provisions of the Municipal Act with respect to plans and specifications for steel and concrete bridges; consultation with town, city and township councils with respect to road and street improvement; the construction of model and experimental roads; educational measures such as the publication of reports and bulletins, addressing public meetings, and the instruction of county road superintendents; miscellaneous matters such as traffic census, the testing of road materials, road surveys and estimates.

Three-fold Classification

It will be seen that the general trend of recent road legislation in Ontario has been toward a three-fold classification, so desirable for management and distribution of cost, and which is being evolved in the following manner:—

1. Local or township roads, each carrying the traffic, or little more than the traffic which is created by the farms adjoining the road; such roads to be controlled by and at the expense of township councils under a township superintendent.

2. Leading market or county roads, the roads radiating from local market or shipping points, which carry a considerable accumulation of traffic; such roads to be controlled by, and to be at the expense of county councils and cities, aided by a provincial subsidy.

3. Main roads between important cities and other terminal points, under the control of the Provincial Department of Public Highways.

Discussion

In the discussion, Mr. Squire declared that the path master had outlived his usefulness; the men often selected were without qualification, and it was time that the post should be abolished.

Bituminous Macadam Roads

By William D. Sohier*

MASSACHUSETTS road system was described in this paper, which contained a detailed description of the type of bituminous road built in this state and the methods employed in their construction. Roads of this type have been made necessary since heavy motor trucks began to become a predominant factor in highway traffic. This, with higher wages, has nearly, or quite, doubled the cost of construction on main lines, because in many instances old roads have had to be dug up on account of their foundations being inadequate for the more concentrated and heavier traffic. Some of the methods employed in connection with the building of bituminous roads in Massachusetts are abstracted from the paper herewith:

Both tars and asphalts have been used in penetration work. The methods are much the same. After we have secured an adequate foundation, well compacted and rolled, we have spread on this enough broken stone to make it four inches deep after rolling. It has been thoroughly rolled until it will not creep under the roller. On top of this we have spread about three inches of 2½ inch stone, and rolled this thoroughly down to about two inches. Into this top surface we spray hot asphalt or tar, under pressure, using one of the various mechanical sprayers or trucks. The asphalt has to be heated to about 350 degrees F.; the tars to about 250 degrees. We spray in about 1¾ gallons to each square yard of surface, finding that this hot bitumen will penetrate about two inches, coating the stone.

We then spread all the ¾-inch stone that can be rolled in, and roll it thoroughly, thus filling the voids in the surface. After this is done, all surplus stone is thoroughly swept off with bamboo brooms, and a surface coating of asphalt or tar, one-half to three-quarters of a gallon to the square yard, is sprayed on the road. This is thoroughly covered with pea-stone and well rolled. This pea-stone has to be constantly swept back or more stone added for a few days, until there is no sign of bleeding. When any work of this character is done in cold weather, the road must be carefully watched every warm day, and especially the next season, and wherever there is any indication of bleeding, more stone or gravel must be spread on it immediately, or the road will be picked up by the passing vehicles.

One-half Covered at a Time

We spray the bitumen on one-half the road surface at one time, cover it, etc., and then do the other half of the width. The ¾-inch stone and the pea-stone are got out beforehand and stacked on the roadside, so that the covering can be put on immediately and the stone rolled in before the bitumen cools.

We hope and believe that roads of this character, built on an adequate foundation and properly maintained, will carry a very considerable traffic for five years at least before they need a new surface treatment, when a good grade of the asphalts is used. Where tar is used, our experience, in common with the best English practice, seems to show that a light surface treatment of about one-half gallon to the square yard is advisable and necessary every two years.

Tar Sand Grout—Brodie Method

Mr. Brodie, city engineer of Liverpool, and one of the most experienced road builders in the world, has developed a form of construction that he believes will and has proved economical for ordinary light city traffic, but not for heavy teaming. Certainly, when some of his roads were twelve years old, in 1914, the roads built by this method were in most excellent condition. They had not been patched or resurfaced, whereas the waterbound macadam road just beyond, carrying the same traffic, had been lightly resurfaced every year.

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* Chairman Massachusetts Highway Commission

The usual method is as follows: After the foundation is properly prepared and well compacted, about 4½ inches of 2-inch to 2½-inch stone is spread and well rolled. This is grouted with pitch and sand-mixed and kept constantly agitated. They then spread and roll in with a steam roller stone of about 1½ inches, which is grouted with pitch and sand and rolled down with a steam roller, the wheels of which are kept constantly wet. Into this top they roll chip or quarter-inch stone. During the last few years they have been putting on a surface application of the pitch and sand and covering it with pea-stone, all well rolled.

The important point is to secure a sand that is the right size to stay in suspension in the tar and not settle to the bottom too quickly. Of course, the coarser the better, if it can be kept evenly in suspension until used. The tar and sand are both heated to about 250 degrees F.

Application of Tar and Sand

Where we have constructed some roads of this character, we have heated our sand and tar on the roadside, using tar kettles and a sand heater to heat the sand. We built a box on wheels, sloping to the end, and had a flexible pipe with a flat nozzle, from which the tar and sand mixture was poured into the road.

We have used this method of construction on quite a number of stretches of road, especially on grades, as it seems to be less slippery for horses than any other type of bituminous surface, especially if the surface coat is left off and the stones are allowed to project a little. The tar and sand seems to stiffen and strengthen the whole road, and we believe the use of the sand prevents the tar from oxidizing for many years, and thereby adds to the life of the road.

Obtaining Even Distribution

We developed this year a very good contrivance for securing an even distribution of the mixture. Two plank bridges were made that bridged the road. They were 2-inch plank, supported in the middle on a 2-inch plank on the crown of the road and built up on the sides. Another 2-inch plank running lengthwise of the road was supported on these, and the man pouring the mixture walked along this plank, held his bucket right against the plank, and walked at the rate of speed that just emptied the bucket in the length of the plank. A flat-nosed bucket was used, with a nozzle about eight inches in width. By placing the bridges the right distance apart, one bucket covered just the proper area, and we poured about two gallons to each square yard of surface. Keeping the bucket against the edge of the plank secured a straight-edge on the road. The plank was then moved along on the bridges across the road and the process repeated, until the whole width was done. There were practically no spaces left where the voids were not filled and the bitumen did not lap.

Gravel Asphalt Mixed Surfaces

There are two forms of bituminous construction that we have used with considerable success in Massachusetts that certainly until a year or two ago have not been used elsewhere, to my knowledge. The processes are about the same, except that in one case sand is used, combined with an asphalt, by either the layer or mixing method, and in the other case a sandy gravel is used combined with asphalt. We have constructed a good many miles of road where these materials have been used. They make very satisfactory roads for medium and light traffic, and cost comparatively little to build.

We do not claim, even for the gravel asphalt road, that it is superior to various other forms of bituminous surfaces, which cost a good deal more to construct, but that where stone is expensive, the haul long, if a good quality of sandy gravel may be obtainable at a very low cost near the road, in many cases a road can be constructed using this material, the first cost of which will be relatively low.

A short description of the process of construction on a particular road will be of interest. A gravel foundation was put in wherever the bottom was bad, and about four inches of local crushed stone was spread and well rolled. On this was spread, as evenly as possible, about three inches of a bituminous mixture, made of gravel that had been run through the crusher and sand or stone dust, mixed with a heavy asphaltic product. The gravel and sand and the asphalt were thoroughly heated, and were mixed in a hot mixer and then carted onto the road and spread. The surface was rolled down to about two inches in thickness, when the mixture was sufficiently cool not to crawl under the roller.

Sufficient, But Not Too Much Asphalt

Great care is necessary to ensure a uniform product, uniformly heated, mixed, and spread, and that sufficient asphalt is used, and no more than sufficient, to bind the mixture properly. The quantity of asphalt has to vary somewhat, according to the amount of voids in the mineral aggregate. The variation is usually from 18 to 22 gallons of the cold asphalt to the cubic yard of gravel. When the mixture is right it has about the consistency of brown sugar, and compacts under the roller, though when it is first spread and rolled it sometimes has a few hair-cracks, which the traffic soon rolls out. The asphaltic product used in this work has a penetration of from 80 to 120 with a Dow penetrometer.

Roads constructed of sand and asphaltic oil were first tried by my commission in 1905, and that road is still in existence, though it has required a considerable expenditure each year, to keep it up, renew and widen it. The gravel and asphalt mixture were first tried by me in 1907, and that piece of road is still in reasonably good condition. Such mixed asphalt gravel roads certainly look as if they would last for a considerable period of time. Several quite long stretches have had already five years' wear. A few, but not many, weak places occur, and these have to be patched, but the expense is very slight.

Discussion

Messrs. C. A. Mullen (Montreal), Jarman (Westmount), Crandall (New York), and E. Drinkwater (St. Lambert), took part in the subsequent discussion.

Removing Stains from Concrete Floors

Oil stains on concrete floors may be removed by using a mixture of 1 pound of oxalic acid in 3 gallons of water, with enough wheat flour added to make a paste that can be applied with a brush. Allow the application to remain for two days and then remove it with clean water and a scrubbing brush. A second application may be necessary in stubborn cases.

Cement Concrete Roads and Pavements

By T. Harry Jones, M. Can. Soc. C.E.*

FOR the past 28 years cement concrete has been used in Canada in the construction of sidewalks. In connection with the earlier walks its use was extended to the building of the walk crossings of street intersections, some of these built over 25 years ago being in good condition to-day. It was also used as a foundation for asphalt and other pavements. Later lanes were built of concrete, one having been constructed in Toronto in 1898. It was only ten years ago that concrete was first used for street pavements, six streets being constructed in Windsor of this material in 1907. Its use has grown till it is estimated that there are about 2,800,000 square yards of this pavement in Canada, of which about 1,600,000 square yards are in Ontario and 600,000 square yards in the province of Quebec. In Ontario alone last year there was laid about 370,000 and in Quebec about 100,000 square yards, while in the United States it is estimated there are over 60,000,000 square yards of concrete pavement in use to-day.

Few Defects on Toronto-Hamilton Road

The most notable example of concrete roadway in Canada is the Toronto-Hamilton Highway, which, with the exception of a few miles at each end, has been constructed between these cities during 1915-1916. It is on the leading thoroughfare between Toronto and Windsor, and is subject to an enormous traffic, which has greatly increased since its construction. Of the work done in 1915 less than four per cent. of the slabs were cracked sufficiently to require filling, and about the same percentage required chipping, and two per cent. chiseling; the greatest percentage of these occurred in the part of the pavement laid late in the fall. The only surface defect in the whole pavement was a hole about 4 in. by 4 in. As a good deal of criticism has been made in reference to these defects, and as the question of joints and cracks is an important one in all pavements, I take the liberty of quoting the conclusions arrived at by Mr. Van Scoyoc, in a report to the Commission after making a personal inspection of every joint and slab laid in 1915.

Poor Work Done in Fall

Joints.—We are willing to admit that joint conditions similar to those found on limited sections of the roadway are undesirable, and that they should be prevented. The summary shows quite conclusively that our trouble developed in those sections laid after October 15th. It is open to serious question if any work should be done in this locality after this date. We were tempted last season both on account of the extremely wet weather earlier which had delayed our progress, and the unusually mild weather which continued well into November. We were successful in preventing any injury to the surface by the frost. We were not so fortunate insofar as the joints were concerned. I believe the explanation of the trouble lies in the fact that concrete expands not only with an increase in temperature, but also with an increase in the quantity of moisture it contains. It contracts not only with a decrease in temperature, but also as the excess water used in mixing dries out. Ordinarily concrete is laid in warm weather. It contracts in setting up and in addition contracts with the cooler weather during the winter months. It shortens more than enough to provide for the increase in length with the increase in temperature during the following summer. In our own case the concrete laid late did not dry out on account of the low temperature. In addition a very wet fall was succeeded by an extremely wet, cold spring. The warm weather came suddenly and the concrete expanded before there had been the usual contraction. Even with these conditions, we believe that there would have been no noticeable trouble if the joints had been vertical, as the forces on the opposite sides of the joint should have balanced each other. All of the joints that have been chiseled through are more or less inclined. In practically every case this inclination is in the direction in which the mixer was working. The only exceptions that I have been able to find up to the present have been on the steeper grades where the tendency of the concrete is to flow down hill and in the joints made at the end of a day's work where lack of care would make the tendency just opposite to that on the other joints.

It is quite possible that wider joints would have decreased the trouble, but it is worth mentioning in this connection that to have increased the thickness of joint to one-half inch would have entailed an additional expenditure of more than $5,000 for the material alone. It is to be anticipated that the maintenance on a wide joint will be greater than that on a narrower one. In our own case a very small part of the $5,000 will put the joints in such shape as to cause no serious inconvenience to travel.

Cracks.—They have been tarred on approximately seven miles, at a cost of less than $25 for materials and $175 for labor. This includes any tarring that was done on the joints as well. Four or five more barrels of tar will do the remaining work.

Surface defects.—If there were signs of this trouble there would be real cause for worry. I believe, however, that both for evenness of surface and quality of concrete our work compares favorably with any work of this kind anywhere."

Simple Cut to Allow for Expansion

Transverse joints in concrete pavements are usually termed "expansion joints" and are left one-quarter inch in width and are filled with tar or asphalt. In some cases even wider joints are advocated. During the warm weather, when expansion occurs, the filling is soft and is pressed out of the joint. As abrasion occurs at the edges of the joint the narrower the joint can be made, the better. The writer is of the opinion that, in city pavements which are watered daily, and on residential streets partly shaded by the trees, little attention need be paid to the expansion of the slab. If a simple cut is made through the pavement which will allow for contraction and care taken that it be vertical, the adjoining slabs should bear the compression.

In the construction of long stretches of sidewalk a good deal of trouble was caused by the buckling of the slabs during the hot weather. This was completely remedied by leaving a one-inch strip in every city block. Why could not the same principle be applied to pavements, doing away with the cross joints and leaving a two-inch bridge, say every 500 feet in length?

Some of Brantford's Experiences

In a two-course pavement (Park Ave.) constructed in Brantford in 1914, a strip 1½ inches wide was left between the blocks of the lower course which was afterwards drawn and filled with sand and the top course of two inches was cut through. No buckling has occurred in this pavement. This matter was also followed in another pavement which was begun last year and is to be completed this year. In Chestnut Avenue pavement, laid in Brantford in 1911, longitudinal cracks have developed, excepting in a strip 110 feet in length, in which a longitudinal joint was left down the centre of the pavement, in which part no cracks whatever have appeared. Applying this principle in the Park Avenue pavement, one-half the width of the pavement was first constructed for the full length of the street and the other half joining it without any filler between. No longitudinal cracks have developed in this pavement. None of these pavements were reinforced.

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*City Engineer, Brantford.

More Cracks in Early Pavements

While cracks in all pavements are objectionable, and should be eliminated, if possible, there has been a great deal more criticism in reference to these in concrete pavements than the facts justify. The writer the other day in a large city counted 120 cracks in about a quarter of a mile on the part (not concrete) between the street railway track and the curb, yet ordinarily they would not have been noticed. Most of the cracks in concrete pavements are in the earlier ones, when the specifications of to-day were not followed. Mr. Edward N. Hines, Chairman of the Board of County Road Commissioners of Wayne County, where their roads are models for other places, writes on March 27th, 1917, as follows:—

> "The work we have put down in the last five years has cracked very little in comparison with that put down previous to that time. We do not regard the cracks as material. A person riding over them with his eyes shut would not know that they were there. Of course, you understand, we would much prefer to have none; but it seems to be impossible to eliminate them entirely. Our experience shows us that the cracking usually occurs early in the summer, and that the greater number of cracks develop the first summer after the road has been opened to traffic; however, a few cracks seem to develop each year. Even after eight years, occasionally cracks are developing."

It will generally be found that cracks in a concrete road are attributable to either an improper foundation or lack of drainage, which generally goes with a clay sub-soil. In country roads cracks are often found on curves, where the road has been widened out, making a fill necessary.

Examples of Durability

In reference to the durability of concrete roads there is a case of one in the United States in use about 25 years, and as usable to-day as when laid. A concrete lane laid in the city of Brantford in connection with a wholesale grocery warehouse was laid in 1902, and, excepting a few small cracks, is apparently in as good condition as when laid.

There is no reason why concrete should not be laid on business streets or those subject to heavy traffic. The experience in Wayne County has demonstrated this. The South Market Street pavement, laid in Brantford in 1912, near the intersection of the two main business streets on a grade of from 5 to 8 per cent., is another example.

Objection is sometimes made to concrete pavements on account of the difficulty in breaking through in making connections or repairs to services. It seems to be forgotten that the same objection largely exists in other pavements which have a concrete foundation.

Replacing Other Surfaces with Concrete

An interesting experiment has been made in Wayne County in re-surfacing an old concrete pavement with a three-inch surface. From the experience obtained in repairing bituminous pavements on a concrete base with concrete, the writer believes that the experiment will be successful, and that when surfaces of other pavements have been worn out they can be replaced by concrete.

One of the difficulties in connection with concrete pavements—and others as well—is that they often have to be constructed immediately after the laying of sewers and other pipes and connections, the putting in of which has been necessitated by the proposed pavement.

The maintenance charges in connection with concrete pavements are less than that of any other class. This will be more appreciable as time goes on, and it is found that other pavements, with which concrete is compared, require replacing, while properly constructed concrete pavements, instead of lasting their estimated lifetime of, say ten years, are good for another ten, and still another.

The light color of concrete pavements instead of being objectionable, is, in the opinion of the writer, desirable. The residential streets and roads generally are, or should be, shaded by trees, and the effect on a dull day or a dark night of turning from a dark pavement to one of concrete is pleasing.

Teamsters using all classes of pavement testify that those of concrete are the least slippery. They are easily cleaned and more readily kept clean. They are less dusty, the surface being freer from voids or waves. This can be tested with the head lights of a motor at night, which exaggerates the unevenness, and while slight irregularities appear in concrete pavements, many others are like the waves of a lake when not too calm.

Discussion

The subsequent discussion was largely on the question of the merits and demerits of concrete roads, the balance of opinion being decidedly favorable to the use of concrete. The subject was opened by Mr. Drinkwater, who cited instances where longitudinal cracks had resulted.

On the other hand, the Chairman, Messrs. A. F. MacCallum (Ottawa), Hogarth, Lambert (Three Rivers), Deer (St. Catharines), and Jarman (Westmount), spoke favorably of their experience with concrete roads. The Chairman pointed out that if contractors who knew nothing about the work used concrete poor results would follow. Mr. Hogarth remarked that a recent examination of the Toronto-Hamilton road showed that 18 slabs had been slightly affected last winter but some of the cracks had possibly developed from insufficient drainage. The appearance of the road from end to end was splendid. Mr. Lambert said that in Three Rivers there was only one per cent. of cracks in 65,000 square yards of concrete, while Mr. Deer remarked that frost penetration in the centre of the road would affect asphalt as well as concrete. Mr. Jarman stated that in Westmount they had found practically no cracks, although the slabs in the spring tended in some instances to heave, settling back with the appearance of warm weather. Mr. Mullen remarked that while concrete would crack, they must not form an opinion upon the performances of some roads, and he told of the doings of certain New York contractors in carrying out contracts in ways which were not favorable to constructing good roads. He spoke favorably of sheet asphalt laid upon concrete foundations.

Annual Dinner

In the evening the annual dinner was held at the Chateau Laurier, the principal speakers being Sir George E. Foster, Hon. W. G. Mitchell, Provincial Treasurer of the Province of Quebec; Sir Sam Hughes, Col. W. Sohier, and Mr. James H. MacDonald, of Connecticut. The speeches were largely of the patriotic order, with an exchange of messages of good-will between the representatives of Canada and those of the United States. Sir George Foster welcomed the entry of the States into the war, replying to a greeting from Mr. J. H. MacDonald. Mr. Mitchell reviewed the advance of the good roads movement in the Province of Quebec, and told of the awakened public opinion which had resulted from the educational campaign and from the visible benefits of good roads.

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Small Details Count

The opening speech at the session on April 12 was by Mr. J. H. MacDonald, who in an informal talk related his experience as State Highway Commissioner of Connecticut. The little things in road-building, he said, were often lost sight of. There were certain essential matters in road construction that must not be overlooked, just as in the same way that the time for repairing a road was when it was finished. They might talk about permanent roads, but he had never seen a road which could be properly termed permanent. The gravel road had done excellent work, and among the essential things for a good road of this type was the selection of the gravel. Experience was the chief factor in selecting a gravel—common sense was the best road-builder that he knew of. Mr. MacDonald described in detail the types of gravel roads in his state, these being constructed so as to meet the different kinds of traffic. Roads, he said, were too often repaired at a wrong time—when it suited the convenience of those who were responsible for the upkeep of the road. It was not necessary to have a road roller; it was the stitch in time that was essential. It would be necessary to construct heavier types of roads throughout the Dominion, but it would be many a long day before either gravel or macadam highways would be abandoned, as they had so many distinct advantages. The question of the cast of screenings was of immense importance in the bonding of the road, and his own practice was to cast the screenings lengthwise with the road.

Stone and Gravel Roads Still Most Important

Mr. Huber pointed out that stone and gravel roads might be expected to give first-class service for many years to come for moderate traffic. Failure of these classes of roads could generally be traced to the neglect of the cardinal principles underlying their care.

Mr. C. R. Wheelock (Orangeville, Ont.) remarked that the roads dealt with by Mr. MacDonald would for the next fifteen years form by far the greater proportion of roads used in Canada.

Correction of Alignments and Grades

By A. Fraser*

THIS paper is confined to a study of the alignment and grade problem, more especially in connection with the trunk roads of Quebec province, setting aside special conditions in mountainous country. The following are the general principles which by experience have been found the most practical and important.

(1) The curves should be planned to afford a sight distance—that is, the greatest distance at which the drivers of two approaching vehicles may see each other—not less than 250 feet. This is the most important rule. The whole question of alignment and grade is a question of the line of sight of unobstructed vision.

(2) The radius of curvature in the province of Quebec has a minimum length of 300 feet wherever possible without incurring a prohibitive cost. If we have to shorten that radius to 150 feet and under, we put danger signs 400 feet distant.

(3) The pavement itself should be widened in the curves, and banked. For the banking of the curves, the following rules are advisable: On a curve of between 2,000 and 800 feet radius the outer side of the pavement should be six inches higher than the inside one; between 800 and 550 feet radius, 7 inches; between 550 and 400 feet, 8 inches; between 400 and 300 feet, 9 inches; and under 300 feet 10 inches.

Compensating for Resistance of Curve

(4) When a curve occurs on an ascent, the grade at that place must be diminished in order to compensate for the additional resistance of the curve. When it is necessary to make a radius of curvature less than 300 feet, we usually follow the principle of reducing the grade on the curve at the rate of one per cent. for every 50 feet that the radius has to be reduced, so that where we are locating a five per cent. grade and have to put in a curve with 200 feet radius, we give a three per cent. grade.

(5) As a rule, there ought to be a tangent of about 100 feet between two curves. Quick reverse curves are disagreeable and dangerous with automobile traffic, and are to be avoided.

(6) All obstacles are crossed as nearly as possible at right angles.

(7) The road on each side of an obstacle should be straight on a length of at least 50 feet when there is a possibility of doing it so without incurring prohibitive expense.

(8) Do not overestimate the advantage of straightness. The curved road around a hill is often no longer than the straight road over it. In addition, a more or less sinuous course is an advantage from a maintenance standpoint, as on a winding road the wheel traffic has a tendency to spread over the entire surface.

(9) Carry the road along the southern or western slope of ridges, if possible, so that it may be less exposed to storms and dry out more quickly after heavy rains and the melting of snow.

(10) The difference in the length between a straight road and one which is slightly curved is very small. We generally follow the line of the old roads as long as there is no bad curve and no danger for the automobile traffic.

Maximum Grade

(11) The maximum grade on our trunk roads is generally five per cent. For a short distance, it is often better to place a 6 or 7 per cent. grade over a limited distance than to make a deep and expensive cut. In the province of Quebec we generally make the grade follow the natural undulations of the ground

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*Engineer, Roads Department, Quebec.

as long as we remain below the maximum grade, and the sight distance is at least 250 feet.

(12) Grades as high as 10 per cent. or over must be avoided at all cost because they are very dangerous, both for horse and motor traffic, in frozen and icy weather.

(13) Deep cuts must be avoided as much as possible, on account of the snow, and the resulting difficulties for traffic in winter and spring.

Summit of Two Intersecting Grades

(14) There is occasionally a road upon which the summit of two intersecting grades is a source of danger, because the drivers of cars which happen to meet just at the top cannot see each other until just before they meet. This meeting point of two grades should be rounded off by a vertical curve so as to insure a sight distance of at least 250 feet.

(15) One of the most important questions that we have to take care of in determining the grades and the alignments is that of drainage. The alignments and grades must be corrected so as to insure a good drainage and eliminate all dangers where possible.

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Afternoon Session, Thursday

The first paper at the afternoon session was by Mr. A. Fraser, engineer, Roads Department, Quebec, on "Correction of Alignments and Grades in Existing Highways."

Mr. T. D. Black, town engineer, Welland, read a paper on "Brick Roads and Pavements."

Mr. W. H. Connnell, chief of the Public Works, Philadelphia, gave an illustrated talk on "Granite Block Pavements."

Mr. Connell's paper comprised an abstract of his paper on the same subject before the American Road Builders' Association, followed by an abstract of the discussions with comment. Accepted practice in the construction of granite block pavements with satisfactory specifications for materials and methods are outlined, which, if carefully adhered to, will produce a road of the best.

"Methods Employed for Making Road Material Surveys" was the subject of a paper by Mr. L. Reinecke, Geological Survey, Department of Mines. He referred to the work of the department in grading and classifying trap rock, field boulders, and gravel. The department worked in co-operation with the provincial highway authorities, and asked the criticism of road-builders for whose benefit the work was carried on.

Mr. Hogarth stated that, owing to the lack of transportation facilities, all attempts to market trap rock on the north shore of Lake Huron had met with non-success. Another deposit in South Ontario was now being marketed. At the present time in Toronto trap rock was worth 25 to 50 per cent. more than limestone, and it was only when a tough, durable stone was required that trap rock was used. In South Ontario they had quarries which supplied good grades of limestone. This gave a fair wearing surface, and the cost was such that municipalities could place the stone on the road. From a practical point of view, they must build with local material. All local material was not of the same grade, and the work that Mr. Reinecke had done in grading stone was of great value; this remark also applied to gravel.

Mr. R. B. Morley, general manager of the Ontario Safety League, spoke of their campaign to reduce street and highway accidents. He described the efforts that had been directed towards education of the school children, the drivers of vehicles, street car motormen, etc. In this campaign, lectures, motion pictures, circulars and posters have been effectively used. Mr. Morley was particularly insistent that the prevention of accidents was largely a matter of individuals showing courtesy towards, and consideration for, one another. Rarely an accident happened for which only one person was to blame. A copy of the recommendations of the Traffic Committee of the city of Toronto was included in Mr. Morley's paper.

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Friday Session

Mr. W. Huber, assistant engineer, Ontario Public Highways Department, was the first speaker at the session on April 13. His paper was called "Modern Road Machinery, Its Selection, Use, and Care."

This paper dealt with the need of modern machinery for modern road-making. For best results the mechanical equipment must be exactly suited to the work, and must be operated by competent men, without loss of time, and under experienced supervision and careful maintenance. Good road-building means the use of machinery in a proper manner and the training of men in its proper operation.

The next paper was on "Highway Bridges and Culverts," by Mr. W. G. Yorston, Assistant Road Commissioner Province of Nova Scotia.

This was followed by a paper on "Bridges and Culverts," by Mr. Lucius E. Allen, engineer, Hastings County, Ontario. Mr. Allen's paper will be reviewed in a later issue.

"Road Oils and Tars" was the subject of a paper by Mr. Arthur H. Blanchard, M.C.S.E., consulting highway engineer, New York. The paper stated: Road oils and tars will be considered from the standpoint of their use in connection with the maintenance of broken stone and gravel. Dust-laying, as the primary object of the use of oils and tars, will not be discussed, as it is believed that special attention, at the present time, should be devoted to such methods of using these materials as will economically preserve the surface of the roads and also render them practically dustless. As the subject will be presented with a view to general adaptability of conclusions and recommendations, it is evident that only conservative practice can be advocated. Local conditions, however, must always be given great weight in the final determination of the method and material to be used. The special committee on materials for road construction of the American Society of Civil Engineers defined bituminous surface as a superficial coat of bituminous material, with or without the addition of stone or slag chips, gravel, sand, or material of similar character.

Oils are not advocated for general use in the construction of bituminous surfaces, for the following reasons: (1) Medium and heavy oils generally require considerable time in which to set up; (2) most petroleum products, while in a fluid state, act to a certain extent as lubricants; (3) it is, therefore, evident that more or less movement of the roadway surface will take place under traffic during the setting-up period; (4) the bituminous mats or carpets formed invariably become wavy and full of humps and ruts under heavy traffic; (5) due to the character of the resulting surface, further maintenance is rendered difficult and costly; (6) prior to the re-treatment of oil-coated roads it is often necessary to remove considerable portions of the bituminous mats with picks and shovels or with scarifiers. After quoting specifications for refined tars, used hot, and cut-back asphalt for surface treatments which have given satisfactory results, Mr. Blanchard dealt with methods of construction. In the case of broken stone and gravel roads, the most efficient method of procedure is to clean the surface thoroughly by sweeping with hand brooms or horse sweepers and hand brooms, the final sweeping being done with bass or other fine fibre brooms. The bituminous material, which is used both cold and hot, is applied to the surface in amounts varying from one-quarter to one-half gallon per square yard, with the aid of pouring cans, hose attached to tanks, hand-drawn gravity distributors, horse-drawn or motor truck gravity or pressure distributors. Some kind of material coating is generally applied to cover the bituminous material. The degree of cleanliness of the surface obtained by sweeping will depend to a large extent upon the details of the original construction. It has been found that a road with a thoroughly rolled and well puddled broken stone wearing surface, composed of road metal from 1 in. to 2½ in. in longest dimension, may be easily cleaned, and the essential adhesion of the bituminous surface readily secured. This method is characteristic of the modern practice of many of the foremost English and French engineers.

Causes of Bituminous Surface Failures

Mr. Blanchard then quoted certain specifications covering constructions and went on: The causes of failures of bituminous surfaces are many. They may be considered from the standpoint of the condition and character of the original surface, the materials used, the method of construction, and local conditions. The failure from the standpoint of the character of the original surface is many times due to failure on the part of those in charge to place the surface in satisfactory condition before the application of the bituminous material. Many cases are noted where bituminous materials are applied over a surface in which are found many pot-holes and ruts or which is dirty, due either to accumulated dust and dirt or to the original method of construction. In many cases a damp condition of the surface has resulted in failure.

From the standpoint of the physical and chemical properties of the material, many instances may be cited in which failure is due to the materials not having the proper characteristics for the conditions under which they are employed. The large percentage of volatile constituents contained in certain asphaltic oils has rendered surfaces constructed with them unsatisfactory because of the long period required for these surfaces to set-up so that the bituminous material will not track or the carpet thus formed will not creep and form waves and humps. In certain cases the use of light oils on tar or asphalt surfaces has softened the original bituminous surface to such an extent as to render the road or pavement unsatisfactory for use.

From the standpoint of construction, failures are due both to the use of too small an amount of the bituminous material and to an excess of material. Improper application, resulting in uneven distribution, is accountable for many failures of bituminous surfaces, while in other cases a lack of sufficient covering of stone chips or material of a similar character, has rendered the surface sticky and mushy.

There are numerous instances where bituminous surfaces have been adopted under conditions which call for the construction of bituminous concrete pavements or even some other type of block pavement. A mat type of construction which has been employed to a considerable extent has proved inefficacious in cases where the amount of motor car traffic was not sufficient to iron out satisfactorily the calk holes caused by the horse-drawn vehicular traffic.

At the afternoon the question of "Road Organization" was dealt with by Mr. George S. Henry, M.P.P. Mr. Henry's paper will be reviewed in a later issue.

Mr. C. A. Mullen, of Milton-Hersey Company, Ltd., Montreal, spoke on "The Contract and Specifications for Paving." A review will be published in an early issue of the Contract Record.

"The Highway in Relation to Land Development" was dealt with by Mr. Thomas Adams, town planning advisor, Commission of Conservation, Ottawa.

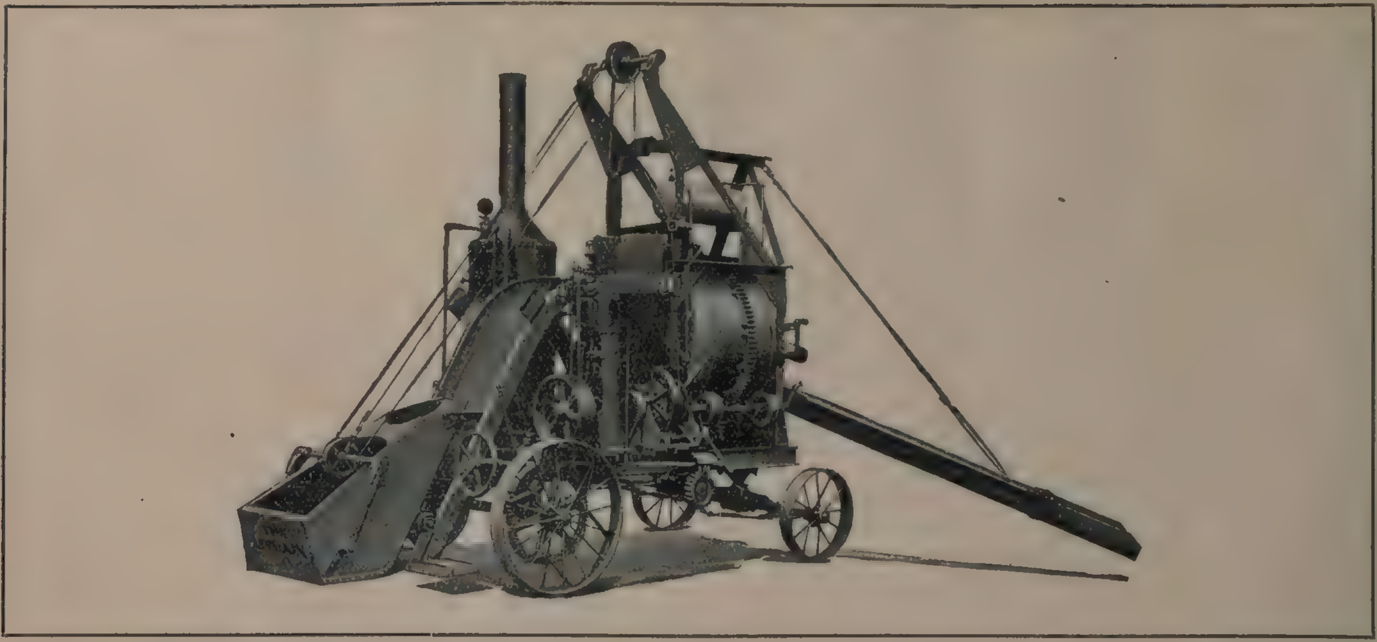
Mr. Linsey Crossley's paper on "Sheet Asphalt Pavements" was also submitted.

In this paper the author outlined the chief requirements for the laying of successful asphalt pavements. Such pavements are not experiments, but have been proved under all kinds of traffic for many years, and they are now based on the fundamental principles of chemistry and physics. The five stages in the construction of a sheet asphalt pavement—preparation of specifications, subgrade, concrete base, binder course, surface on top—were each considered in turn, and their essential requirements outlined. The reader is referred to the Contract Record of January 17, where the same author takes up this subject in substantially the same manner.

At the suggestion of Mr. Hogarth, the following resolution was referred to the Resolutions Committee: That an investigation be made and representations be made to the Provincial (Ontario) Government to have placed in the Municipal Act a clause enabling co-operation between the owners of property and the municipality in erecting sub-drainage along the sides of the road sufficient to take care not only of the water from the roadway proper, but also from the farm property abutting on that road." The motion was supported by Mr. A. H. Foster, who said that such a resolution, if put into effect, would do away with the long, deep ditches along the sides of the roads. Co-operation between farmers and road-builders was essential for this purpose.

New Officers

The annual meeting of the Dominion Good Roads Association was held on Saturday morning. The following officers were elected: President, Mr. J. Duchastel, city engineer, Outremont, P.Q.; vice-president, Mr. S. L. Squire, honorary president, Ontario Good Roads Association, Waterford, Ont.; secretary-treasurer, Mr. George A. McNamee, Montreal; honorary presidents: Messrs. U. H. Dandurand, Montreal; W. A. McLean, Deputy Minister of Highways, Ontario, Toronto; B. Michaud, Deputy Minister of Roads, Province of Quebec; Captain O. Hezzelwood, Toronto; directors: Messrs. T. Adams, town planning advisor, Commission of Conservation, Ottawa; A. L. Caron, Montreal; W. Findlay, Ottawa; C. R. Wheelock, Orangeville, Ont.; R. S. Henderson, president, Manitoba Good Roads Association, Winnipeg; George Hogarth, chief engineer, Highways Department, Province of Ontario, Toronto; J. W. Levesque, M.L.A., Montreal; A. F. Macallum, Commissioner of Works, Ottawa; P. E. Mercier, chief engineer, city of Montreal; J. A. Sanderson, Oxford Station, Ont.; Dr. E. M. Desaulniers, M.L.A., Deputy Minister, Provincial Legislature, St. Lambert, P.Q., and representatives of the engineering departments of Nova Scotia, Saskatchewan, and New Brunswick. With two exceptions, all the gentlemen named were on last year's list of directors.



A Mixer for Concrete Highways

The concrete highway, when built under modern methods, is one of the most economical, both from the standpoint of first cost and from annual maintenance. Like all other types of permanent highways, one of the most important things in connection with the building thereof is that it should be provided with sufficient under-drainage. No matter how well the road is built, if the drainage is not taken care of the roadway cannot give the best of results. For highways where there is not a large amount of traffic there are other materials which probably would be as economical as concrete, but for any highway where there is a large amount of traffic, as on our main thoroughfares, there is no other material which will compare with concrete in cost of construction or in vehicle mileage per dollar of cost.

Within the last three or four years much has been done toward the improvement of machinery for the building of concrete roadways, and the result is that the cost of building a roadway has been greatly reduced and also a better type of roadway is being built than it was possible to build with former methods. We illustrate herewith a type of concrete mixer which is used for building concrete highways and which has done much to reduce the cost of construction and improve the quality of the work. The special features of this type of machine is that it has a traction drive, moving itself about by its own power and also has a forward loader and rear discharge so that the materials may be distributed on the centre of the roadway in front of the machine. As the machine moves along it always keeps close to the materials, thus cutting out the use of all wheelbarrows. The materials being thrown directly into the power loader saves the labor of several men. The materials are discharged at the rear of the machine, directly to the roadway.

Another modern feature about this machine is that the drum, instead of being mounted regulation height, is mounted very high from the ground, so that when the materials are being discharged the discharge opening of the drum is sufficiently high above the ground to give great descent for the concrete. The machine, instead of being provided with a delivery boom and bucket as was used on the older type, has a spout or concrete chute, which is made to turn in a complete half circle. This concrete spout also has gates that may be opened up at any point, so that the concrete may be distributed to any part of the roadway.

A machine of this type will deliver concrete at a cost, at least, 10 per cent. less than that of older types. Another advantage is that, on account of less working parts, there is less liability of breakdowns or trouble with parts getting out of order. These machines have been used in the city of London for the last three years, and about thirty miles of permanent roadways have been laid. They are also used in the cities of Halifax, Ottawa, Windsor, and Montreal, and many other smaller towns and cities, for building permanent roadways of all types. The machine here illustrated is known as the London elevated drum paving mixer, and is manufactured by the London Concrete Machinery Company.

It is claimed that this machine has proved especially satisfactory for building concrete roadways for the following reasons:

1. On account of the machine having traction drive, forward loader, and rear discharge, thus cutting out the use of all wheelbarrows, either for loading the machine or for delivering the concrete, the roadway can be put down at a saving of 10 per cent. in labor over that of the older type of machines.
2. The concrete is delivered in a continuous flow, delivering a uniform mixture at all times. This is very important in the building of concrete roadways.
3. The machine is very simple in construction and has very few working parts; therefore, the life of the machine is very much longer than the machines with much complicated mechanism.

Residents along the portion of the Toronto-Hamilton highway through the lower end of Etobicoke Township have lodged a protest with the Minister of Public Works against the widening of this section being carried out as a local improvement, under legislation put through during the past session of the Ontario Legislature. The Minister was unable to give the deputation much encouragement but as one result of the petition the commission will probably investigate as to the relative cost of widening on the north side rather than on the south, as now proposed, it being claimed that this would materially reduce the cost and protect valuable property along the lake front.

Mainly Constructional

East and West—From Coast to Coast

During the month of March, 1917, in the city of Quebec, there were 74 permits issued, representing a value of $129,699.

A new automatic chlorination system has recently been installed in Windsor, Ont., for the sterilization of its drinking water.

Mr. C. H. Rust, city engineer of Victoria, B.C., for patriotic reasons, has again voluntarily reduced his salary, this time from $400 to $300 a month.

At a public meeting of citizens of Hawkesbury, Ont., recently a resolution was passed, and will be forwarded to the government, requesting that proper wharfing facilities be built for the town.

A building by-law has been passed in Port Colborne, Ont., placing all building operations carried on within the town under the control of the council. Restrictions have been placed on the west side.

A new sewer system, to cost approximately $154,000, has been tentatively recommended by Mr. Willis Chipman, of Chipman & Powers, Toronto, to the City Council of Woodstock, Ont., as necessary to satisfactorily solve the overflow problem which the city faces at present. He will make a fuller report later.

Good progress is reported on the new Canadian Northern terminal at Vancouver, B.C., the driving of the 2,500 piles being carried out for the support of the new building. A large platform is being constructed, 35,000 square feet in area. This will carry the concrete floor, and the pouring of the concrete is being put under way.

Building permits issued in Vancouver, B.C., during the month of March, this year, number 46, and are valued at $33,715, as against 48, valued at $205,465, in the same month in 1916. For the first three months of the year the figures are 119 permits, value $159,540, compared with 94 permits, value $293,749, in the corresponding period last year.

A new school has been erected on Gledhill Avenue, Toronto, at a cost of approximately $60,000. The building at present contains 12 rooms, but provision has been made that it may be enlarged to 29 rooms. The school is on the border of the city and township, just north of Danforth Avenue. For this reason it was necessary to have a special water main laid from Danforth Avenue for the convenience of the pupils, at a cost of $400.

Extensive changes in the plans and specifications submitted to the Board of Education of Chatham, Ont., for the Queen Mary School addition, are proposed by the board, who are now taking active steps to get the work under way with the hope of having the $40,000 extension completed by September next. Mr. J. Methvin has been appointed architect to supervise the construction and make the necessary changes in the steel structure.

Montreal's building permits for the first three months of the year show a hundred per cent. increase in the value of buildings. The figures for this period are 193 permits, valued at $995,920, while for the corresponding period last year the figures were 218 permits, valued at $483,420. For the month of March, this year, there were 105 permits issued, value $343,460, compared with 119 per mits, valued at $243,345, during the same month last year.

It is understood that the plant of the Union Cement Company at Owen Sound, Ont., may be doubled in capacity this year. The present capitalization of the company, $200,000, is to be increased to $1,000,000, the additional amount being supplied by investment of Chicago capitalists. The contract for the enlargement has been let provisionally to the Fuller Engineering Company, of Allentown, Pa., and the work is to be gone on with at an early date.

It is understood that the gold, lead, zinc, and silver areas at Stirling, in Richmond County, C.B., are to be worked on an extensive scale this spring. Men have been employed throughout the winter in sinking shafts and doing other necessary work. A new drill hole has been sunk a distance of 500 feet, which is said to show good results, and another is being put down at some distance from the first. It is stated, also, that the erection of a smelter is contemplated.

The new military hospital in Vancouver, on which construction was started in the month of February, will, it is stated, be ready for occupancy early in the month of May. It is situated in the rear of the Vancouver General Hospital, and is connected with it by a covered gangway. The building, two storeys in height, is arranged in the shape of an "H," and contains eight wards. Each wing is 164 feet long by 33 feet in width, containing two wards on each floor.

It was recently decided by the city of Vancouver to commence salvage operations for the water mains lying at the bottom in the First Narrows. These mains are valued at $27,000 by City Engineer Fellowes, who reported to the Board of Works that it would pay to recover the pipe, as it could again be put into commission. There are two 12-inch mains, which, when connected up, would be used in cases of emergency. They will have a capacity of 2,760,000 gallons per day, and the cost of making the connection is estimated at $6,230. These two mains cost $40,000 to put down. Originally there were six pipes across the First Narrows, but when the government decided to deepen the Narrows it was necessary to break and remove them, and three 18-inch pipes were put down instead. Even these larger mains, however, are said to be inadequate.

The Canadian Collieries, Ltd., Dunsmuir, B.C., is making a number of additions and extensions to its No. 5 mine. It is also considering unwatering No. 4 shaft at Puntledge, with a view to handling the lower seam coal through the shaft and the modern equipment on the surface. The company is also preparing to operate in the seam of coal which has recently been discovered above the lower seam of No. 4 slope mine. The coal coming from the new seam will be handled at the present tipple of No. 4 mine, while the lower seam coal, so soon as connection is made between No. 4 shaft and the present workings, will be all handled by the shaft. The company is constructing 120 additional coke ovens to supply coke to one of its largest customers, and is considering the erection of thirty additional ovens for the Ladysmith smelter, which is now preparing to start operations.

Mr. W. A. McLean, Deputy Minister of Public Works for Ontario, recently attended a conference between representatives of the city of Hamilton, Ont., and Wentworth County in regard to the working of the Suburban Area Act. Mr. McLean explained that under this act, if the city agreed to go in with the county in building main roads on a basis of 30-30, the province would pay the remaining 40 per cent., and for the maintenance of these roads the province would contribute 20 per cent. The arteries he suggested were the Dundas, Stony Creek, Beach, and Caledonia roads. Two members each would be appointed on a committee by the city and the county, and these four would choose a fifth. This board would have charge of the roads, and would work in conjunction with the city engineer, subject, however, to the county in the matter of a limit to the road expenditures. At the suggestion of one of the aldermen, the chairman of the Good Roads Committee of the County Council agreed to have a report prepared showing the cost of maintaining the sections of the roads under consideration—twenty miles.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Aylmer, Ont.
The Town Council plan road repairs, and will be in the market shortly for crushed stone. Members, Councillors Cline and Finch.

Blenheim, Ont.
The Town Council plan to lay cement sidewalks in a few weeks. Clerk, P. S. Shillington.

Brampton, Ont.
The Peel County Council will spend $50,000 on new roads, etc., this summer. Clerk, D. Kirkwood.

Chicoutimi, Que.
Work will start in May on the construction of waterworks fifteen miles long for Pitre Laberge. Wood pipes will be used, with cast iron fittings. Owner buys material. Engineer, J. A. Claveau.

Dorval, Que.
The town contemplate the construction of a filtration plant, Clerk, Alphonse Decary. Dupont, Roy & Baudouin, 225 St. James St., Montreal, will probably be engineers.

East Zora Township, Ont.
Tenders are being received by Reeve R. A. Webber, R.R. No. 6, Woodstock, until April 18, for trenching, laying, and covering 8,033 lineal feet of tile, building of catch-basins, one concrete intake, and one concrete outlet. Plans and specifications with F. J. Ure, engineer, Woodstock.

Edmonton, Alta.
The City Council will call tenders shortly for four steel tanks to be added to filtration plant. Engineer, A. Haddow.

Halifax, N.S.
The city will start work shortly on the construction of three sewers, costing $36,400, on Quinpool Road, Jubilee Road, and Bloomingdale. Engineer, H. W. Johnston.

Hepworth, Ont.
The Town Council plan to construct a drainage system. Clerk, W. R. White.

Leamington, Ont.
The Town Council will widen Mill Street from 22 feet to 27 feet and lay 4-inch water main. Clerk, R. M. Selkirk.

Ottawa, Ont.
Tenders will be received by the secretary of the Board of Control until April 24 for 2,200 lineal feet of 54-inch, 5,900 lineal feet of 48-inch concrete and segment block. Specifications at the office of MacLean Daily Reports, Ltd., 345 Adelaide St. W., Toronto. Commissioner of Works, A. F. McCallum, City Hall.

Peace River, Alta.
The Municipal Council plan to spend $5,000 on the construction of sidewalks and purchase of additional fire equipment.

Quebec, Que.
The Provincial Government contemplate the construction of a macadam or gravel road from Victoriaville to Ste. Angele de Laval. Minister Highway Department, Hon. J. A. Tessier.

Quebec, Province of.
The Department of Highways, Provincial Government, plan to construct a highway from Beauceville to Sherbrooke. Engineer, G. Henry, Parliament Buildings.

Sarnia, Ont.
Plans and specifications are at the office of the engineer, J. A. Baird, City Hall, who is receiving tenders until 5 p.m., April 20, for the construction of a 30-foot concrete pavement on the London Road from Christina to Russell Sts.

Strathroy, Ont.
The Town Council plan to repave Front and Frank Streets. Material to be chosen. Councillors, Hill, Geddes, and Dale.

Thetford Mines, Que.
The by-law for new dam for reservoir, costing $50,000, has been passed. Secretary-treasurer, Alfred Gagnon, Notre Dame St.

Three Rivers, Que.
Plans for a waterworks plant for the city are ready and work will be done by day labor, under City Engineer Z. Lambert. Project includes new aqueduct system, driving of artesian wells, concrete reservoir, etc.

Tilbury, Ont.
The Town Council plan to lay concrete pavements on Canal Street and Carlyle Ave., as petitioned for and will secure estimates at once. Clerk, W. A. Hutton.

Tillsonburg, Ont.
The Town Council plan to macadamize Ridout Street and also to purchase oil for various streets. Deputy Reeve, Mr. Dean.

Toronto, Ont.
Tenders close April 24 for the following works: Asphalt on Greenwood, Kingswood, Silverbirch; asphaltic concrete on Kingswood; brick block on Kingswood; concrete on Kingswood and Mitchell. Specifications at Works Department. Secretary, Thomas McQueen.

Woodstock, Ont.
County plans road improvements during the year to cost $10,000. W. Forbes, 25 Light Street, County Road Supt.

Tenders will be received by the chairman, A. G. Gahagan, for prices on asphalt and cement pavement on Riddle St., from Drew to Dundas St. Clerk, John Morrison.

Sewer system, costing $154,000, for the Town Council has been recommended by the consulting engineers, Chipman & Power, Mail Building, Toronto. Clerk, John Morrison.

CONTRACTS AWARDED.

Cap De La Madeline, Que.
Alp. Aubin, St. Jerome, County Lac St. Jean, has been awarded the general contract, and will purchase one 50 h.p. motor, electric water pump, about three miles of 15-inch sewer pipe, 15,840 feet of 6, 8, and 10-inch cast iron pipe, quantity of cement in connection with the construction of an aqueduct, pumping station, and reservoir, costing $100,000, for the Municipal Council.

Halifax, N.S.
City let contract for sewers to the Cook Construction Co., Ltd., 335 Queenpool Street. Cost $70,000.

London, Ont.
The Gartshore-Thompson Pipe and Foundry Company, Stuart W., Hamilton, have been awarded the contract for cast iron pipe for the water mains to be constructed by the Utilities Commission, City Council.

Peterboro, Ont.
H. B. Taylor & Son, Aylmer St., have been awarded the contract to supply the city with sewer pipe required for 1917. Engineer, R. H. Parsons.

Sandwich, Ont.
Merlo, Merlo & Ray, 296 Winderm Rd., Walkerville, have been awarded the general contract for the construction of a water main, costing $20,457, for the Town Council. Engineers, McColl & Fletcher, Gas Building, Windsor.

Three Rivers, Que.
The grading work for the highway from here to Grand Mere for the Provincial Government, Ottawa, has been awarded to the Grand Mere, Three Rivers Highway Company, Ltd., Grand Mere, who will start work in the spring. Grading work only to be done this year. Engineer, G. Henry, Parliament Buildings.

Railroads, Bridges and Wharves

Arthabaska, Que.
Plans and specifications are with the secretary-treasurer, L. Lavergne, who will receive tenders until noon, June 9, for repairs and painting of steel bridge for the County Council.

Dorval, Que.
The Canadian Pacific Railway, Grand Trunk Railway, and the Town Council are having plans drawn for a $50,000 tunnel, to be 200 feet long, with sidewalk on one side. Wall of concrete, concrete floor, with steel supporting beams. Engineers, Dupont, Roy & Baudouin, 225 St. James St., Montreal.

Halifax, N.S.
The Nova Scotia Tramway, corner Barrington and Sackville Streets, are having a survey made for an extension of their tram line. Company is in the market for additional rolling stock, rails, ties, and general construction material. Engineer, W. E. Barrett.

ESTABLISHED 1886

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Alphabetical Index of Advertisers
Page 16

Vol. 31 April 25, 1917 **No. 17**

Principal Contents

Page
Editorial ... 365
Constructional Details of Big Aqueduct ... 367
Nova Scotia's Largest Highway Bridge ... 370
Stettler's New Water Supply ... 373
Recent Amendments in Quebec Legislation Affect Privileges of Builders ... 374
Paving Contract and Specifications Defective ... 376
Road Planning More Important Than Construction ... 377
Excess Water Injurious to Concrete ... 378
Ultra-violet Rays for Water Purification ... 379
Practical Hints for the Contractor ... 382
Mainly Constructional ... 384

Better Contracts

THE perfect specification or the perfect contract may be likened to the alchemic elixir for prolonging life--long sought, but never found--and it is about equally certain that none of the three ever will be found. It is not, however, because thought has not been given to the evolution of a more suitable form of contract or specification. The importance of revisions and readjustment has been fully grasped, but oftentimes sadly neglected, and, although much has been written and spoken about the imperfections and defects in these documents, they seem as far removed as ever from the much-sought and highly-desirable finished product. In an article in this issue by Charles A. Mullen, director of the paving department for the Milton Hersey Company, a number of very interesting and weighty considerations are discussed which are of great importance in the production of a more suitable and desirable form of contract or specification. Although his remarks are intended primarily to refer to paving contracts, a great deal is applicable, and indeed essential, in connection with the contracts and specifications for work of other descriptions.

* * *

The author emphasizes the point that, as the basis of the contractor's relation to the owner or engineer is the contract drawn up between them with the accompanying specifications for the work, any improvement that is to be made in the relationship of these two parties must be produced by a corresponding improvement in the documentary indications of their relationship. A well-drawn and easily understood contract and specification, in which the duty of each party to the agreement is clearly stated, draws them together in a more mutually helpful relationship. But, however well draws a contract or specification may be, there is still need for competent supervision and inspection, since it is not the actual letter that always counts, but rather the interpretation of it permitted in actual practice.

The contractor on the one hand and the engineer or owner on the other have interests diametrically opposed; but, although opposed, it is pointed out that the contract should be in the nature of an agreement between equals. One party should be ready and willing to deliver the goods specified, the other ready and willing to pay the price. Each has his rights which must be respected by the other, and any attempts to improve the present conditions must recognize this and eliminate the master-and-slave contracts that seem to be the rule at the present time.

A great many contracts contain much that is not necessary and omit much that is necessary; they express requirements that will never logically be demanded and prohibitions that may properly be allowed. The rule should rather be: A reason for everything and everything in its place. The lack of precision in this regard seems, in Mr. Mullen's opinion, to be due to an over-estimation of an engineer's ability to accomplish the impossible. He is expected by the uninitiated public to provide the antidote for ills of every description.

* * *

A very interesting question is asked by Mr. Mullen: Why is a contractor asked to guarantee the work that the engineer designs, directs, and inspects? The engineer holds at all times the upper hand, tells how the work is to be done, what to do, and when to do it. When it is completed, he clears himself of all responsibility, makes the contractor guarantee his work and make good any losses that may occur. To quote Mr. Mullen, his words applying particularly to paving work: "Fair play demands that the engineer guarantee his own work. I do not mean to actually suggest that he be asked to give a bond and make good the loss, but that the contractor should not be required to make good a failure if it is in no way his fault. The engineer's reputation should suffer, not the contractor's pocket. If this rule held true, engineers would be much more careful in the work that they specified and constructed."

The idea contained in this quotation would, if properly carried out, place responsibility on the proper shoulders. It seems absurd to attempt to make a contractor guarantee and maintain work that is laid out and supervised by an engineer. It is well known how it works out in cities where pavements are laid under these conditions. The very fact that a five-year bond is required is an excuse for city officials to neglect the proper and careful inspection of the materials, knowing that all defects are remediable under the guarantee by the contractors. Much harm can be prevented by a proper placing of the responsibility and the maintenance of professional good name and reputation would instigate a better workmanship if the engineers were required to guarantee their work.

Increasing Membership of New Engineering Society

THE membership of the British Columbia Institute of Civil Engineers, organized last fall, is said to exceed eighty, and keen interest is being manifested by all in the aims of the association. Mr. Seaton, assistant superintendent of dredging, Public Works Department, Canada, 614 Birks Building, is organizer for Vancouver. The officers of the Victoria branch (elected at last meeting) are as follows: Chairman, E. N. Horsey, resident engineer, British Columbia Electric Railway Company; secretary-treasurer, S. P. Macrae, assistant engineer, Public Works Department, Canada, on Victoria breakwater and piers, formerly resident engineer on construction, C.N.P.R.; under-secretary, F. M. Preston, assistant city engineer, Victoria; councillors: E. P. Todd, engineer in charge of city streets, Victoria; A. F. Mitchell, acting district engineer, Public Works Department of Canada, for Vancouver Island; J. B. Lambert, engineer, Public Works Department staff, Vancouver Island; W. M. Stokes, maintenance engineer, E. and N. R. R.; A. D. Noakes, partner in firm of Swannell & Noakes, engineers and land surveyors; J. H. Devey, formerly engineer for Lord Rhondda (D. A. Thomas), on Peace River development scheme.

Selection of Architect of Vital Importance

THE first and the most vital step in any building operation, writes A. F. Moratz in the Ohio Architect, is the selection of an architect, upon it depending much of the ultimate success or failure of the project. The architect should be selected on the merits of his completed work, and upon his honesty and integrity. The works and the character of the man who is commissioned to plan and supervise the construction of a building should be thoroughly investigated before he is employed.

After an architect has been selected, it is important, if the best results are to be obtained, that his advice be heeded and his drawings and directions faithfully adhered to. Absolute confidence must exist on the part of the owner toward the architect, both as to his honesty and ability, as many matters may arise during the progress of the work that will test this confidence to the limit.

More Attention to Form Work by Engineers

THAT there is much to recommend the contention that the engineer should prepare the design of form work, was the opinion of Allan Graham, expressed in a paper read at the Concrete Institute, London. The engineer will generally have no hesitation in setting out the design of centering for a bridge or other equally important work, but, for some reason or other, the design of ordinary form work, which plays such an important part in the cost of reinforced concrete, is never considered. There is no doubt that a thorough understanding of the principles underlying the every-day practice of concrete form design is one worthy of the best engineering talent. With this understood, the problem can be analyzed, the requirements realized, and the design decided upon that will be most economical and efficient, giving due consideration to the salvage of material.

Strength is not the entire consideration, but the problem is rather one of designing a set of forms that can be erected, taken down, and many times re-used during the progress of the work. Various authorities place the cost of form work at anything from 20 per cent. to 60 per cent. of the total cost. The possibility of reducing this hindrance to the more general use of concrete ought to be sufficient inducement to give the matter close consideration.

Concrete Laid in Cold Weather Stands Up Under Severe Test

THE difference in deportment in cold weather of concrete work properly designed and properly treated under premature removal of the forms is well illustrated by a piece of work designed by the office of C. A. P. Turner, consulting engineer, Minneapolis, and executed in Fort William, Ont., some years ago. The roof slab was cast at a temperature of 20 degrees below zero, and the material was put in hot, properly treated, and at the end of less than eight days a fire prematurely removed the forms, which subjected the slab to the severe temperature stresses of high heat and generation of steam in cavities that blew out pits and defaced the surface somewhat, but the slab stood up. It required only a little plastering, a little touching up of the fireproofing of the columns to make the job good in the end, and the foreman on the job had such extraordinary confidence in the efficacy of the methods advised and employed that he remained on this roof and played the hose on his lumber which was above the roof and just started to catch fire, while the supports were burning out below him. The fire was so quick and hot that bricklayers on their scaffolds left their tools and their coats, as they had no opportunity to save them.

Revision of Montreal's Building By-Laws

THE Province of Quebec Association of Architects have written to the Montreal Board of Control asking the latter to receive a joint deputation of the society, Builders' Exchange, and Canadian Society of Civil Engineers on the subject of the building by-laws. This is a very old question; it has been discussed for years, and, as a result of much work, a new code was drawn up by a committee representing the interests affected. This code has been amended and has been passed on by the city's legal department. There the matter rests; and, in consequence of the long delay, the deputation will ask that the code should become operative at the earliest moment. The city is now under a set of by-laws framed many years ago, which, it is contended, are not suitable for present-day conditions.

Mr. Frank Barber and Mr. R. O. Wynne-Roberts, consulting engineers, have removed their office from 57 Adelaide Street East, Toronto, to 40 Jarvis Street.

Constructional Details of Big Aqueduct

The Contractor's Plant and Methods for the Manufacture and Placing of Concrete on Contracts 30 and 31 are Described in this Article, the Fifth of a Series on the Construction of the Winnipeg Waterway

By John Armstrong*

THIS is the fifth of a series of six articles describing the construction of the 85-mile concrete aqueduct section of the Greater Winnipeg Water Supply. The previous articles (Feb. 28, March 7, March 21, March 28) describe the general features of the project, the contractors' organization, and the methods of excavation and backfilling. This article is intended to describe the contractor's methods of preparing foundation to receive the concrete and the plant and methods used for the manufacture and placing of the concrete on the construction of the aqueduct on contracts Nos. 30 and 31.

General layout of contractor's plant on contract No. 30.

The aqueduct trench was usually excavated about one foot above the bottom of concrete, this depth of material being removed immediately prior to the pouring of the concrete. In dry soils this prevented the cracking of the exposed bearing surface, which often occurs when a lengthy exposure is made. In exceptionally dry weather the bearing surface was kept damp by light sprinkling.

Sprinkling With Sand Overcomes Surface Curling

In fairly damp materials it was noticed that the surface often broke and curled under the shovels when being trimmed to the final dimensions. This condition was satisfactorily overcome by lightly sprinkling the surface with sand and tamping the disturbed bottom solid again.

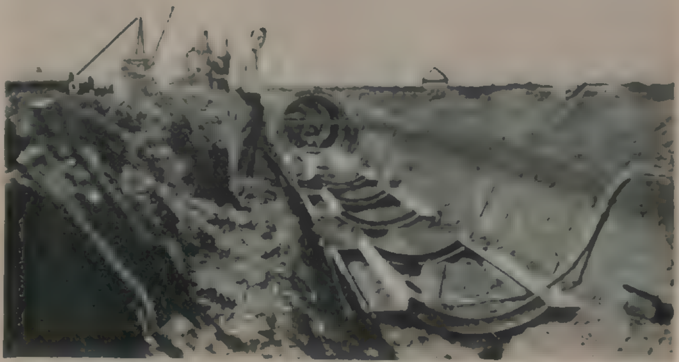
Where considerable water was encountered a policy of leaving the final foot of excavation until just prior to pouring concrete prevented the softening and mucking of the bottom by the passage back and forth of the workmen.

On contract No. 30 the trench was comparatively shallow, and the mucking of this final foot of excavation was done satisfactorily by hand. On contract No. 31, where the trench was from six feet to eighteen feet in depth, the material was loaded into yard buckets by hand, the buckets being hoisted and handled by the derricks which are shown in some of the cuts in the previous articles. These derricks and their operation will be described more in detail later.

As soon as the foundation was properly prepared the invert concrete was poured. As soon as these inverts hardened sufficiently the arch concrete was placed. The forms used were of steel for both arch and invert work, although wooden invert forms were found satisfactory in a few cases.

Invert Construction Methods

The inverts were poured in pads of a standard length of 15 feet, with a copper expansion joint between each two pads. Each pad was screeded neatly to form by means of a screed made of angle iron, each leg being about 2½ inches. This heavy screed had a slight tendency to sag in the middle, but this difficulty was easily overcome by using a light wooden screed for the final working of the surface. The surface of the invert, after being surfaced with a wooden float, was finally finished with a steel trowel. A wood strip ⅞ in. x 1¼ in. was placed in the invert shoulder as a water-stop for the construction joint between the invert and arch. When the concrete was partially set, the shoulders of the invert were brushed with a stiff wire brush to give a rough surface for the receipt of the superimposed arch.


Invert and arch forms on contract No. 31

The arches of horseshoe shape were poured in standard lengths of 45 feet, the inner and outer forms being bolted together and spaced apart to the proper dimensions with wooden spacers. When the forms were drawn the bolt holes were filled first with a tight wooden plug some three inches long, driven about midway through the concrete wall, then each end sealed by a rich grout.

Spading Counteracts Settlement

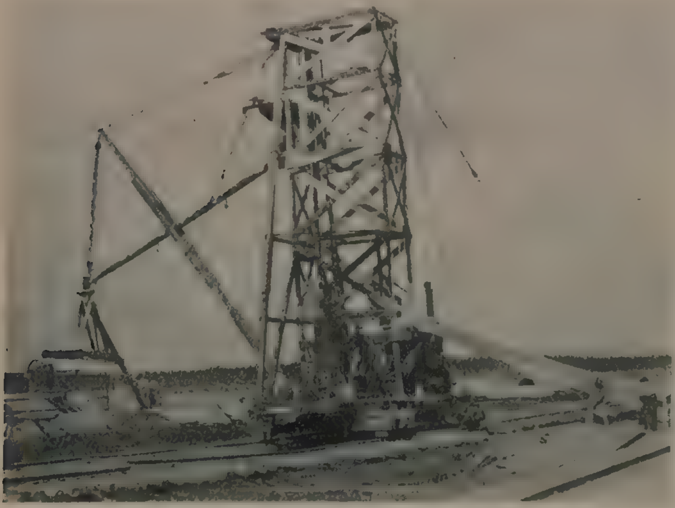
Immediately prior to the pouring of concrete, the inner forms were oiled with a fairly heavy oil, and in hot, dry weather it was also found to be beneficial to lightly sprinkle the inner form with water. This oiling and sprinkling gave a very smooth finish, and greatly diminished the tendency of the concrete to stick to the forms and scale when the forms were drawn. As the concrete was poured it was kept constantly puddled by a gentle churning motion, to facilitate the release of imprisoned air bubbles and to work the whole into a uniform and homogeneous mass. It was also found to be of great benefit to continue spading the tops of arches for a considerable length of time after the pouring was completed—in fact, as long as possible without interfering with the setting of the concrete. This spading counteracted the greater settlement occurring in the outer portion of the concrete and the tendency to pull away between the more vertical portion of the wall and the flatter top portion. The much denser concrete obtained on the crown, due to this spading, was readily seen. Previous to the adoption of this spading the finishers frequently scraped off and threw away anywhere from three to six cubic feet of excess concrete from each 45-foot arch, but afterwards this did not occur, and it was frequently necessary to borrow a few shovelfuls from other concrete being poured.

---

*Division Engineer

Form Equipment

The equipment of forms varied at each camp, depending upon the amount of the aqueduct allotted to it. The gradient of the aqueduct varied, necessitating a different size form for each different grade. However, an average complement might be taken as twelve invert profile forms and six arch forms. Invert pads and arches were poured in alternate sections, as for instance: If inverts No. 1, 3, 5, 7, etc., were poured one day, then, when these were sufficiently set and the forms removed, pads 2, 4, 6, 8, etc., would be poured, and the same system pursued with the arches.



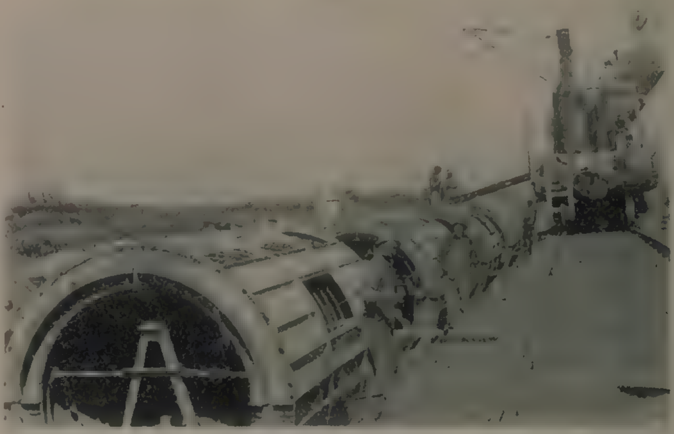
Tower type concrete mixing and placing equipment on contract No. 31.

Pressure sections and syphons for the river crossings were circular instead of horseshoe shaped, and the arches for these sections were built in 15-foot lengths instead of 45-foot lengths used for the horseshoe shapes or gravity flow arches. On contract No. 30 the contractors used two mixing plants for concreting, one pouring inverts and the other pouring arches. The machines varied in capacity from one-half cubic yard to one cubic yard. These mixers were mounted on trucks travelling on a track laid on longitudinal stringers close to the aqueduct trench, and were self-propelling.

Handling Aggregate

The gravel aggregate for the manufacture of concrete and the Portland cement were supplied by the District and placed for the contractor by the District's railway, at the site of work. The gravel aggregate was deposited on the contractors' platforms, while the cement was delivered in cars, which the contractor's men unloaded.

During the first season's work the aggregate and cement were handled from beside the railway track to the mixer at or near aqueduct trench, a distance of about eight feet, by derricks, a method still in use on contract 31, but abandoned by the contractors for contract No. 30 in favor of hand labor, using platforms laid from the aggregate piles and cement stores, and wheelbarrows or carts for transporting the materials to the mixers. The derricks proved cumbersome machines, and many delays, due to breakdowns and derailments, were occasioned by them to the concrete work.



A car mixer placing concrete for arches. Contract No. 31.

The inside forms were moved on trucks mounted on a narrow track laid on the invert. For moving outside forms different methods were used; one camp used a small derrick, mounted on the mixer truck; another used a small derrick, mounted on a self-propelling truck, and a third used a small derrick, mounted on a truck towed by the mixer engine.

Different Methods of Mixing and Placing Concrete

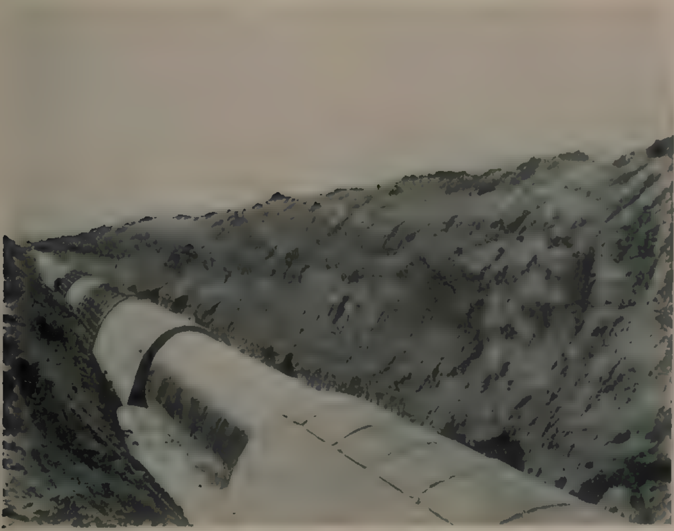
On contract No. 31 different methods were used for mixing and placing concrete at each of the three camps. At Camp No. 1 one mixer of one cubic yard capacity was used for both invert and arch work. This mixer was mounted on an ordinary railway flat-car, travelling on a track some fifteen feet from the edge of the aqueduct trench and moved by its own power. The aggregate and cement were handled from beside the District's railway track to the mixer by a five-ton derrick with a 65-foot boom. This derrick also handled the outside forms.

At Camp No. 2 a similar mixer to the foregoing was used to pour the arches, and a small half-yard mixer was used for pouring the inverts. The materials and outside forms for arches were handled by a five-ton derrick, while the materials for invert work were handled by wheelbarrows.

At Camp No. 3 the invert work was done by a stationary mixer of one cubic yard capacity, set upon a stage some six feet high, close to the aqueduct trench. The aggregate and cement were hauled by horse power to an inclined track from beside the railway to the mixer. From the mixer the concrete was delivered about one thousand feet each way in steel dump cars of about one cubic yard capacity, running upon a narrow-gauge track along the edge of the trench. A single horse was used to move these cars in trains of three cars. A single horse was also found sufficient to haul the aggregate car up the incline from the railway to the mixer.

Mixer Arrangement for Arch Pouring

Arch work was done by a mixer discharging from a tower. The mixer was of one cubic yard capacity, mounted on a railway flat-car, upon which was also located a hoisting engine. The materials were delivered from beside the railway to the mixer up an incline similar to the one used on the invert mixer; this was operated by the hoisting engine. The concrete when mixed was discharged into a bucket and hoisted some 100 feet to the top of the tower and there dumped into a chute leading to the arch forms. This chute was of sufficient length to reach and pour three arches without moving the machine, and was arranged with joints, permitting the delivery of the concrete at any point desired. This machine was self-propelling and mounted on a track of fourteen feet gauge.



Method of arch construction. - Contract No. 31.

Any of the foregoing methods of concreting appeared capable of carrying out the work imposed upon them, but little opportunity was afforded to show the actual capacity of any of these plants. The contractors made the mistake which is often made on work of this nature, of concentrating too much attention upon concreting plant and neglecting other vital items, which, if properly organized, might prove more profitable than concrete work.

Might Have Organized Better

The progress of this work, especially contract No. 31, had depended largely upon the contractor's capacity to carry forward the excavating, the pumping, and final preparation of the trench for concrete. Concreting plant capable of doing two miles of aqueduct in a season was furnished, along with excavating and pumping plant only capable of doing one mile, the effect of which must have been to greatly reduce the contractor's margin of profit, and has amply demonstrated that, unless a contractor's equipment is properly balanced and organized, both progress and profits will suffer.

Low Costs on Hamilton Grade Separation Work

LOW costs were generally experienced in connection with the Kenilworth Avenue subway at Hamilton, Ont., completed some time ago. This work was to eliminate a grade railway crossing on the main line of the Grand Trunk Railway from Hamilton to Niagara Falls and Buffalo. The subway crossing is at practically 90 degrees, with approach grades of 4 per cent., within plain concrete retaining walls having a clear width of 50 feet between them. The superstructure is built for four tracks, and consists of a ballasted I-beam floor carried on plain concrete abutments and a centre steel bent on concrete footings. The floor is carried on 24-inch I-beams at 2-ft. centres parallel with the railway tracks, which are filled solid with concrete except for a V-cut between bottom flanges. The beams are carried on the abutments and unusually deep plate girders spanning between the columns of the centre bent.

The excavation, reaching a minimum depth of 2[illegible] below base of rail, was in soft clay, changing gradually to a hard gray clay and to soft shale, and then hard shale at the lower parts. Mucking was done by hand labor, with dump wagons and teams. The top was loosened by plow, but blasting was necessasy in the deeper cuts. A total of 12,000 cubic yards was excavated, at a cost, after crediting the sale of the wasted material, of 72½c per cubic yard.

The concreting was performed with a one-yard steam mixer, mounted on a car, using hand buggies for distribution. The cost of the concrete work in the substructure, amounting in all to some 1,530 cubic yards, averaged $6.50 per cubic yard. This included not only the bare material and labor of mixing and placing, but also the building and removing of forms, surface finishing and waterproofing of the joints. The superstructure concrete, on a similar basis, ran about $9.80 per cubic yard for the 200 cubic yards placed. These low costs were in part due to small freight charges, the material supply sources being close at hand, but chiefly to the economical handling of the work generally.

The unit cost of waterproofing the concrete floor, including a due share of the construction and operation of the gauntlet tracks (which was divided between this and the superstructure concrete work) was 15c per square foot for 3,500 square feet of bridge floor. The waterproofing consisted of four plies of 10-ounce felt, with a centre ply of burlap, each layer being well swabbed with coal tar pitch before laying the next. Between the felt and concrete was placed a layer of resin paper, to keep a free joint, and the same was repeated on top of the last layer. The whole was then covered with a two-inch protective coat of cement mortar, reinforced.

The cost of the hand-railing was unusually low, some 800 lineal feet being erected at slightly over 60c per lineal foot. It comprised cast iron standards with flanged bases and cast poles to receive the 2-inch rail pipes. The low cost was due to the low cost of materials and almost negligible erection costs.

The usual factors contributing to building failures are careless mixing and depositing of concrete, early removal of forms, lack of proper inspection, and competition without the proper supervision. But more prominently than any other cause stands out the season of the year in which a majority of the recorded failures have occurred.

Nova Scotia's Largest Highway Bridge

Newly Completed Six Span Steel Structure With Long Fills, Totaling About 2500 Feet — Concrete, Granite-Faced Piers Built in Caissons

By W. G. Yorston[*]

THE Lennox Passage bridge, the erection of which was completed last fall by the Government of Nova Scotia, is perhaps one of the most ambitious highway structures so far erected by that province. The bridge in question connects the mainland of Cape Breton Island with Isle Madame. On the latter island there is a population of about 5,000, and before the erection of this structure connection with the mainland was only obtained by means of a scow ferry at Grandique, about two miles east of the site of the bridge.

In selecting the site for the bridge advantage was taken of two islands in Lennox Passage known as Benoit Island and West Burnt Island. The structure as built consists of about 1,400 feet of earth embankment, faced with heavy stone rip-rap and 1,100 feet of steel superstructure, all of which is shown more clearly on the accompanying plan showing the site of Lennox Passage bridge.

Swing Span Permits Channel Traffic

It became necessary in designing this structure to provide a swing span in the main channel, as this route is largely used by coasting craft in the Passage, from points in Prince Edward Island and on Northumberland Strait to points in the Bras d'Or Lake and the Sydneys. The traffic, both of coal and agricultural produce, is comparatively large.

The bridge structure as erected consists, in the main channel, of three fixed spans of 200 feet each and a swing span of 205 feet. Over the back channel there are two fixed spans of 150 feet each. The superstructure is designed according to class "C," the lightest loading provided for in the "Nova Scotia Specifications for Steel Structures." Provision was made in the calculations for the placing of a concrete floor the whole length of this bridge, this floor being put on at the time of erection.

The superstructure rests on concrete piers and abutments, built from foundations up of that material. In order, however, to overcome the disintegrating effects between high and low water, due to the action of frost, the exposed faces of all piers and abutments between a point distant three inches below extreme low water mark and a point seven feet above low water mark were built with granite quarry-faced ashlar. The rest piers under the ends of the swing spans when opened were built of creosoted hard pine timber, full ballasted to the underside of the bridge seat.

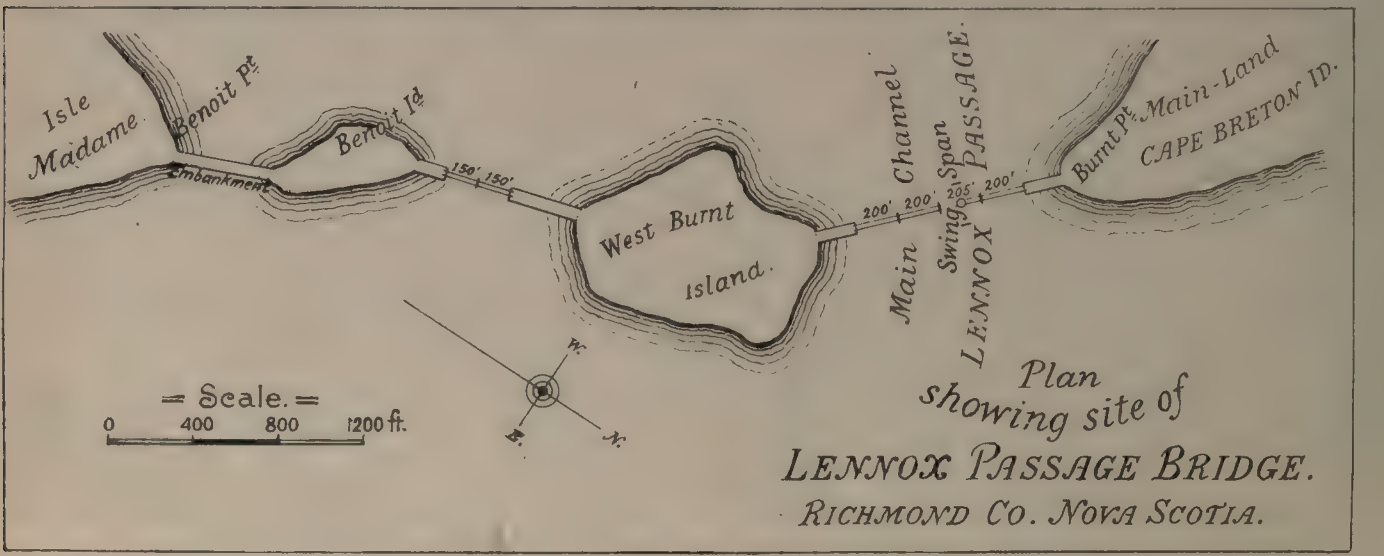
Piers Built in Caissons

The foundations encountered were partly rock and partly hard-pan of a very dense nature. In prosecuting this work all loose material was dredged from the site by means of an orange-peel bucket. When all loose material had been removed the site was then examined by a diver, and, if found entirely fit for foundation, a wooden caisson without bottom was then sunk over the excavation so made, and carefully lined and levelled on its site. Concrete in bags was then placed around the bottom edges of the caisson, in order to prevent the escape of concrete when placed inside the caisson. The caissons were then filled by means of bottom dump buckets up to the elevation at which granite masonry was to be commenced. The concrete used was mixed one part cement, two parts sand and four parts gravel or broken stone, which was the proportion of the ingredients for all subaqueous work. For concrete above water the proportion used was one part cement, two and one-half parts sand, and five parts broken stone. The top of piers and abutments, as well as all wing walls, etc., are made of concrete.

As before stated, the flooring of this bridge is made of reinforced concrete. As the traffic to be anticipated is all of a light nature it was thought sufficient to make a wearing surface of concrete, allowing an extra thickness of one and one-half inches at the crown of the roadway.

The Province's Largest Highway Bridge

Besides being the largest highway bridge so far erected by the Government of Nova Scotia, this struc-



Plan showing site of LENNOX PASSAGE BRIDGE. RICHMOND CO. NOVA SCOTIA.

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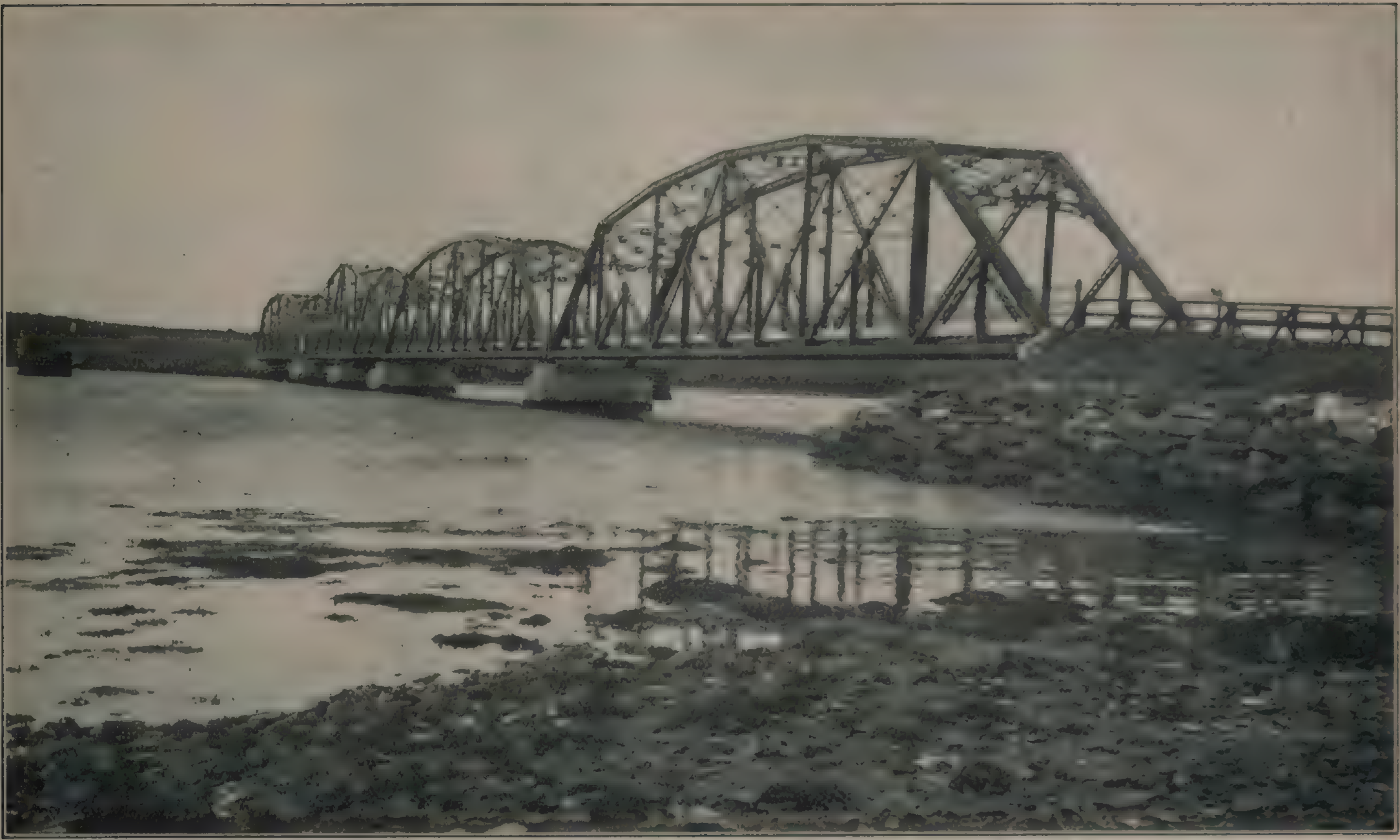
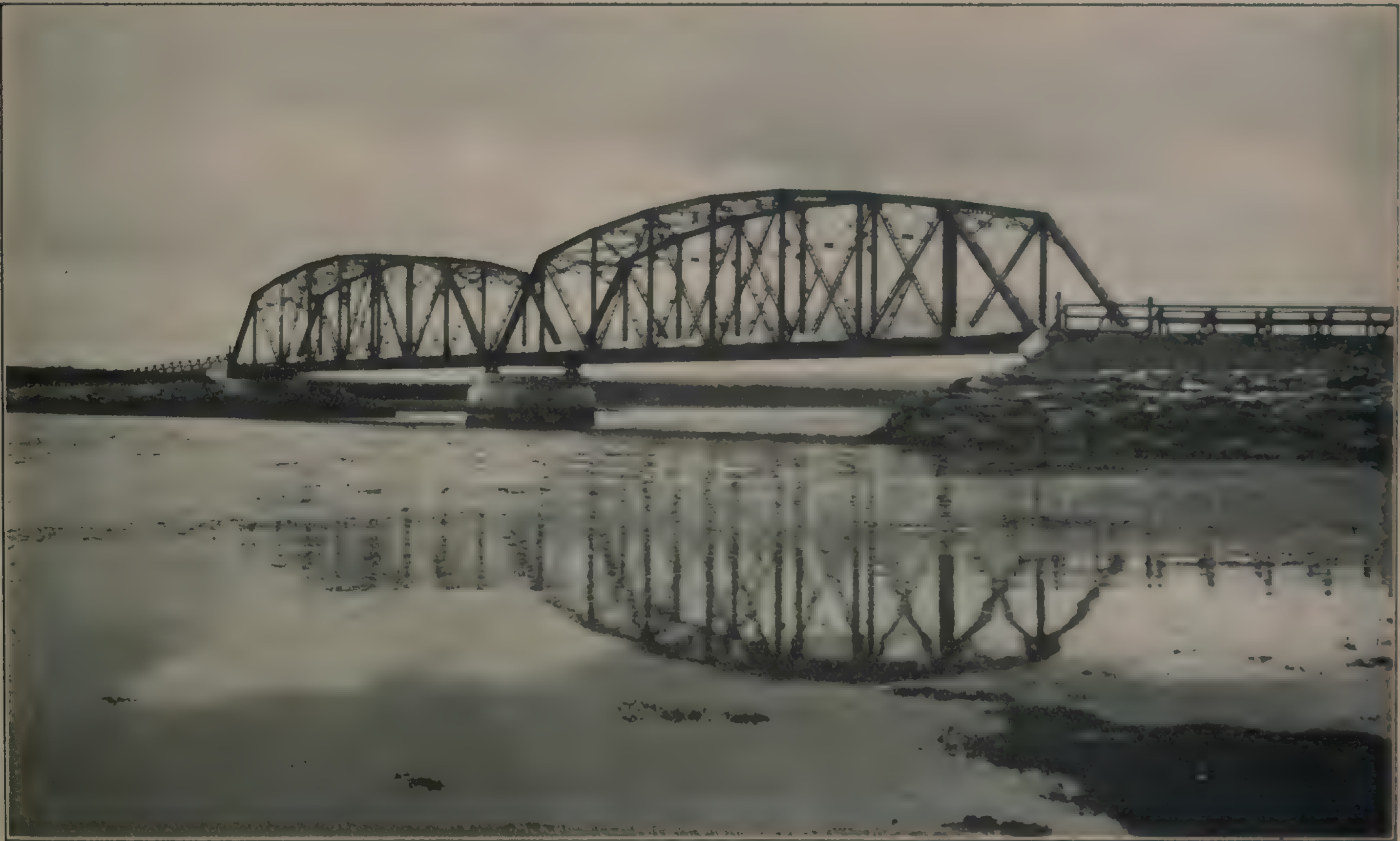
[*] Assistant Road Commissioner, Province of Nova Scotia.



Main channel section of Lennox Passage Bridge; three 200-ft. fixed spans and one 205 ft. swing span.



Back channel section of Lennox Passage Bridge; two 150 ft. spans.

End view of Lennox Passage Bridge, showing concrete floor.

ture is also the heaviest type in the province. Great care is being taken with the field painting of this structure, as it is anticipated that it will be subjected to considerable action from salt spray. The field painting consists of two coats of graphite paint of different colors.

This bridge was designed by W. Chase Thomson, consulting engineer, of Montreal. The work of erection was supervised in the field by W. D. Robertson, C.E. The contractors for the substructure were the Standard Construction Company, Ltd., of Halifax, their price being $49,904.80. The successful contractors for bridge steel and concrete flooring were the Maritime Bridge Company, Ltd., New Glasgow, N.S., the amount of their contract being $59,860.50. The contracts were awarded to the lowest tenderer in each case. The low embankment connecting Benoit Island with the mainland of Isle Madame was not included in the contract for the substructure, but was built by day labor. This bridge, fullv erected and field-painted, will cost in round figures about $130,000.

Plaster Has Effect on Quiet Conditions in Buildings

ONE of the important factors in producing quiet conditions in buildings has been determined by prominent architects to be the kind of plaster that is applied to the walls, states the School Board Journal. When a sound wave strikes a wall the following occurs: Part of the sound is absorbed, part is transmitted, and part is reverberated, the volume reverberated and transmitted being dependent entirely upon the volume absorbed and the volume absorbed is, in turn, dependent upon the character of the plaster. A dense, smooth surface will reflect sound waves much more readily than a material that is porous, as a dense surface absorbs very little of the sound wave at each impact, and many reflections are necessary before it dies out, and in many auditoriums it has developed that an overlapping of syllables has persisted for several seconds after the source of sound has ceased. On the other hand, a surface porous in nature will absorb a greater quantity of energy at each impact, and sound quickly dies away. It will, therefore, be seen that the ideal material for plastering the interior of school buildings, from the view point of acoustics and quiet conditions would be that which reduces reverberation of sound waves to a minimum.

There are two kinds of plaster in general use today, viz., gypsum hard wall plaster and hydrated lime plaster. There is, however, one great advantage in favor of hydrated lime plaster—its ability to absorb and deaden sound—and it is this advantage which is now recognized by the architect and impelling him to accept hydrated lime plaster as the standard plaster for such buildings as school buildings where good acoustics or quiet conditions are desirable.

Gypsum plaster, when passing through the process of hardening on the wall, takes up in chemical combination approximately 25 per cent. water. This chemical addition causes the plaster to "set," or crystalize, each particle becoming firmly united to its nearest particle. When this action is completed there results a panel of plaster which is dense, hard, and brittle. Hydrated lime plaster hardens in an entirely different manner, this process being dependent upon the carbon dioxide in the atmosphere combining with the lime in the plaster, and this combination drives off all the water that was used in mixing the plaster. The mixing water originally required space, and this water, being driven off, leaves the hardened plaster with millions of tiny, dead air cells. These air cells are absorbers of sound, and when a sound wave strikes the wall, a large majority of it is absorbed, thus reducing to a minimum the reverberation which provides defective acoustics in a room or auditorium.

The durability of hydrated lime plaster cannot be questioned when one considers that for years it was the only plastering material on the market. Many readers probably well remember the days of construction when no other material was used for plaster except lump lime, sand, and hair, and these jobs are still standing to-day in an excellent state of preservation. Hydrated lime plaster accomplishes the same fine results that were formerly gained by the use of lump lime. The old disadvantages of lump lime, such as pitting and popping, and the expense and inconvenience of slaking are eliminated with the use of hydrated lime. The material is delivered on the job all ready for the immediate addition of sand and water, and in some cities it is mixed with the sand at a mixing plant and delivered ready for mixing with water. The covering capacity of hydrated lime plaster is the same as that of gypsum plaster.

Stettler's New Water Supply

A Small Town Installation Uses Well with Steam Driven Pump and Reservoir

By H. Baron*

Owing to extensions in the water mains and a consequent increase in consumption of water, the town of Stettler, Alta., last summer put down a second well, one well having supplied the needs of the town until then. Tenders were let for drilling a 6-in. hole at $1.25 per foot, and the casing was furnished at $89 per 100 feet. The new well is located between the power house and the 50,000-gallon reservoir, being only a few feet from the latter.

The first water was struck at about 80 feet. Drilling was continued through a sandy, blue clay, slightly more water coming through all the time. At 140 feet the flow reached a maximum. At about 100 feet a 2-ft. vein of sandstone prevented the 6-in. casing going further, but drilling was continued to 210 feet, with a 5-in. casing.

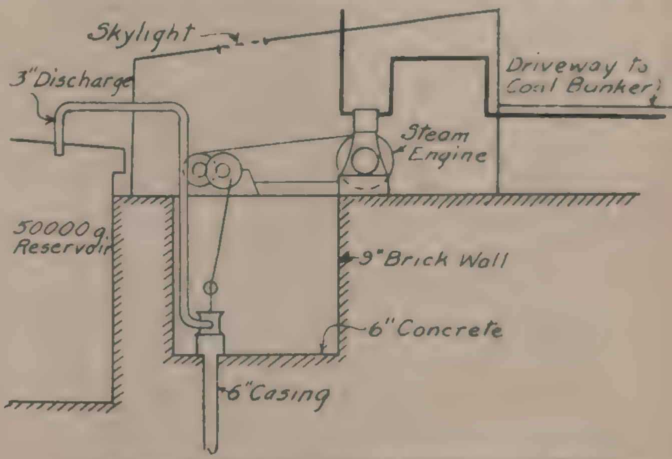
Pumping Equipment

The pressure of the water was sufficient to force it to about 55 feet from the surface of the ground. The pump used is of the usual deep-well type, with a barrel 3¾-in. diameter by 16-in. stroke, screwed to the end of a 4-in. pipe, and let down 100 feet into the well, with 20 feet of pipe and a strainer below it. The plunger is connected with the pump-jack above by ash rods and screwed couplings. This arrangement permits the plunger and check-valve to be entirely withdrawn for repairs without the necessity of disturbing the pipe. The pump-head is so arranged that the discharge can be forced directly into the town's mains at a pressure of 60 pounds per square inch, should further occasion require it, but at present the discharge simply goes into the reservoir. The jack, which is a single geared affair, is belted to a small vertical 5-in. x 6-in. engine. This equipment was considerably less costly than a special steam-driven pump-head, costing only about $70. It also permits of a thorough test of the capacity and endurance of the well at small expense.

A chamber 7 ft. square and 7 ft. deep, lined with a 9-in. brick wall and a 6-in. concrete bottom, was made round the pump-head, and the roof of the house above has a movable skylight directly over the well, so that any future work on the well can be easily carried on through it.

Good Quality Water

The well, which is 60 feet from the old one, does not so far seem to affect it in any way, and the combined delivery from both wells is from 1,200 to 1,500 gallons per hour. The water seems to be of excellent quality, working well in the power house boilers, and it is hoped that the negotiations now in progress with the C. P. and C. N. railways will result in the building of tanks at this town for supplying their locomotives with water from the town wells.



Diagrammatic sketch of waterworks arrangements at Stettler.

A sketch of the pump house is appended.

The work of installation was performed by Mr. H. Baron, superintendent at Stettler for the past two years, and who has now been appointed chief engineer for the town of Camrose.

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[*] Chief Engineer, Camrose, Alta.

Pulverized Fuel for Locomotives

The Prairie Provinces have large reserves of coal, but much of it is unsuitable for railway fuel on account of its liability to cause fires by sparks from locomotives. During recent years experiments have been made respecting the use of pulverized fuel for locomotives. It has been used for several years in connection with certain metallurgical work and found to be of great economic importance. The tests made on locomotives show that the use of pulverized coal is more efficient than the ordinary method of burning coal, and, in addition, does not cause smoke, cinders, or sparks. Its use would not only be an economy, but would add largely to the comfort of the passengers.

The railway fuel problem in Central and Western Canada is an important one, and, considering the rapid introduction of pulverized fuel on railways in the United States and the economy to be effected by its use, it will be only a short time before such locomotives will be used in Canada.

Ottawa Branch C.S.C.E.

The Ottawa branch of the Canadian Society of Civil Engineers will hold their fourth luncheon for the present year at the Chateau Laurier on April 26, at 12.45 p.m. sharp. Col. D. Carnegie, member and ordnance advisor of the Imperial Munitions Board, will address the members on the subject, "The Manufacture of Munitions in Canada as a Permanent Asset to Canadian Industry."

Recent Amendments in Quebec Legislation Affect Privileges of Builders

By Andrew R. MacMaster, K. C.

THE following address on "Recent Amendments in the Civil Code (Quebec), Affecting the Privilege of Builders, Suppliers of Material and Others," was delivered at a luncheon of the Montreal Builders' Exchange on April 12:

At the last session of the Legislature of the Province of Quebec some very important changes were effected in the privileges accorded to workmen, suppliers of materials, builders, and architects, on the property of which the value has been increased by their work or materials. I will endeavor to sketch the new features of the law, wherein it differs or resembles the former enactments, and what procedure must now be followed in order to avail oneself of the advantages conferred.

To devise a satisfactory law of builders' privilege is not an easy task. There are several interests which may conflict—that of the workman, that of the supplier of materials, that of the builder, and that of the owner. The task is rendered more difficult by the attitude of many principal contractors and owners, who seem to regard the registration of privileges not merely as burdens placed on the properties in which they are interested, but as in very deed hostile acts warranting immediate reprisals by way of loss of contract or otherwise.

The supplier of materials and the sub-contractor is often between the Scylla and Carybdis—fearful of losing his rights as a privileged creditor if he does not register and fearful of losing at least the good-will of the principal contractor, the architect, and the owner if he does.

The new law, as did the old, gives to the workman, the supplier of materials, the builder, and the architect a right of privilege over other creditors on the immoveable, but only to the extent to which their work and materials have enhanced its value.

New Law Changes Order of Precedence

A change made affects the order of those entitled to the privilege. Under the old law the order of precedence was as follows: The laborer, the workman, the architect, the builder, the supplier of materials. Under the new, the laborer and workman are combined. the word "workmen" being used to designate "the artisan, the laborer, and generally everyone who makes his living by manual labor"; next comes the supplier of materials; next the builder, which term includes both contractor and sub-contractor; and last the architect.

The privilege of the workman exists for arrears up to twenty days, whether he was engaged by a proprietor putting up a building for himself or by a contractor. No formality is necessary for the creation or preservation of this privilege, and its lasts until thirty days after the construction is ready for the use for which it is intended. Within this thirty days the workman must sue his debtor, who will usually be the contractor or a sub-contractor, and he must call the proprietor and the registrar into the case.

In order to protect the proprietor against this undisclosed hypothec or mortgage on his property the law allows him to retain on the contract an amount sufficient to pay these privileged claims, and refuses to the builder the right to exact any payment on account of the contract price before furnishing to the proprietor a statement of all amounts due by him for labor and materials.

New Law More Certain

The provisions of the new law differ somewhat widely from the old. Under it the workman did not have to register his privilege so long as the work was being proceeded with, but he had to give notice to the proprietor of the fact that he had not been paid either in writing or verbally before a witness when each payday came round. Then within thirty days from the time the building had become ready for the purpose for which it was intended he had to register his claim.

The trouble was that, under the old law, the workman who availed himself of his rights and gave notice to the proprietor was himself only too often the recipient of a notice to immediately quit his job. The new law, in restricting and limiting the privilege, has made it more certain.

The supplier of materials is given a privilege on the building in which the materials supplied to the owner or builder have been used or for the construction of which they have been specially prepared.

The privilege is created by the registration of a notice given to the creditor or his representative, and applies only to those furnished or specially prepared, but not delivered, for the immoveable in question. The law offers one striking novelty. It gives the supplier of materials a privilege for the price of materials specially prepared for a building, although they have not been delivered on the job or incorporated into the building. The law also grants to the unpaid supplier a right to revendicate, in case of the insolvency of owner or builder, the materials he has supplied, so long as they have not been incorporated in the building.

Supplier of Materials Has More Rights

The old law merely directed the supplier to advise the proprietor of the contracts made by him for the delivery of materials before they were delivered, mentioning their cost and the immoveable for which they were intended. Failure to give this notice lost the supplier his privilege. The old law further provided that, in order to meet the privileged claims of the supplier of materials, the proprietor was entitled to retain on the contract price an amount equal to that mentioned in the notices he had received. The supplier, to retain his privilege, must now sue his debtor within thirty days of the date at which the construction is ready for the purpose for which it was intended. Under the old law the supplier had to sue within three months of the giving of the notice to the proprietor if he desired to retain his privilege. This often brought about an absurd state of affairs, in that the delay for suit had often expired before the merchandise had been used or even before all of it had been delivered.

In many cases—perhaps in most—the sub-contractor is also a supplier of materials. In such event he should conduct himself as such, giving what notices are required.

In the event of being merely a sub-contractor, to create this privilege he must advise the proprietor of the contract he has made with the principal contractor, and within thirty days after the end of the work he must register his claim and give notice to the proprietor. He only gets a privilege for the work he does subsequent to the notice that he has given the proprietor of his contract with the principal contractor. In other words, the creation of his privilege is subjected to two conditions—first, a condition precedent; the notice to the proprietor of the subs' contract with the principal contractor; second, a condition subsequent: the registration of a statement of his claim within the stated delay. Within six months after the end of the work a suit must be taken or the privilege will become extinct.

The proprietor may retain, on the contract price, sufficient to meet the claims of the sub-contractor. Under the old law the sub-contractor was obliged, in order to create his privilege, to advise the proprietor of his contract with the principal contractor within eight days of its signing, and, if he failed so to do, he lost his privilege. The new law is fairer and less rigorous.

The Builder and Architect's Claim

The builder or the architect's claim is created by the registration within thirty days after the end of the work of a statement of claim of which notice is given to the proprietor within the same delay.

Procedure

As far as the workmen's claim is concerned, no notice or registration is necessary, but the workman must take a suit against the debtor within a delay of thirty days after the end of the work. In this suit the proprietor and the registrar must be brought in, the proprietor because his property is sought to be charged, the registrar so that he can make note of the suit in his books, and thus give warning of the existence of the privilege to anyone proposing to buy or lend money on the property. In order to obviate a multiplicity of suits for small sums, the law provides that several workmen may join in one action.

In dealing with the procedure involved in this department of law it will be noted that two basic requirements are laid down—notice to the proprietor of the immoveable and registration. The notice to the proprietor is to advise him of the rights which are being created against his property, the registration is to advise those desiring to deal with the owner concerning the property or with the builder, of the situation.

Following out these principles, we have seen that the supplier of materials obtains his privilege only upon the registration of a notice which has been given to the proprietor, and applies only to those supplies furnished or specially prepared and not delivered, after the registration of such notice.

The privilege so created will become extinguished after thirty days after the end of the work, unless the supplier takes a suit meanwhile, into which he must call the proprietor and the registrar.

Sub-Contractor's Course of Action

The sub-contractor, to create his privilege must, as we have seen before, advise the proprietor of the contract he has made with the principal contractor. I believe it would be well to have this notification to the proprietor served by a bailiff, or, if the mails are used, sent certainly by registered letter. Registration, in the registry office, must follow within thirty days of the end of the work.

An amendment of article C.C. 2103 repeats some of the provisions already enacted, but conveniently and clearly sets forth the essential characteristics of the notice or memorial of the creditors' claim: (a) The claim must be drafted in the form of an affidavit of the creditor or his representative and sworn to before a justice of the peace, a commissioner of the superior court, or a notary; (b) it must contain the name, occupation, and residence of the creditor, the nature and amount of the claim, and the cadastral number of the immoveable upon which the construction is being placed.

I consider that the following practice will meet fully the requirements of the law and also be found convenient:

That the claim be prepared in triplicate. That at the foot of the claim there be appended a notice to the proprietor, drawing his attention to the claim, and a further notice to the registrar, requiring its registration. Let the claim and notice be served on the proprietor by a bailiff, and then put before the registrar both the remaining documents, asking him to affix his certificate of registration to both. Then file with him the document which does not bear the bailiff's return or affidavit of service, and retain the one which does. The privileged creditor will thereupon have in his possession a copy of his claim bearing upon it satisfactory proof of its having both been served and registered.

Cancellation of Privilege

A further amendment which has been made, and which I believe will prove useful, is the following:

After the expiration of six months after the date of the registration of any privileged claim or from that date of the end of the work, which ever be the latest, if no action has been taken to preserve it, any interested party may call upon the registrar to radiate the privilege by the following procedure:

The party interested prepares an application to the registrar demanding the cancellation on the ground that the six months from the end of the work or the registration of the claim, which ever be the latest, has expired; this application he supports by his affidavit. Then, in order that an opportunity be afforded to the privileged creditor to take such steps as he may deem necessary to protect himself, this application must be served on the privileged creditor or his representative eight days before it is filed with the registrar.

If a suit has been taken the registrar is bound to radiate the registration not only by direction of a judgment, which might go without saying, but also on production of a certificate from the prothonotary that the action has been discontinued.

Have Opened Office

Messrs. Archibald & Holmes have opened offices at 402 Excelsior Life Building, Toronto, Ont., as engineers and builders of reinforced concrete and steel structures. Mr. Geo. H. Archibald has been associated for the past ten years with the Geo. H. Archibald Company, Limited, Winnipeg, Man. Mr. A. R. Holmes was secretary-treasurer and engineer of the McKinnon Holmes Company, Limited, of Sherbrooke, Que., but has recently sold out his interests in that company.

Paving Brick Manufacturers Meet

The Institute of Paving Brick Manufacturers meets in convention at St. Louis, Mo., on May 8 and 9. Secretary, H. H. Macdonald, 830 B. of L. E. Building, Cleveland, Ohio.

Many Defects in Paving Contracts and Specifications

By Chas. A. Mullen*

It is only necessary to look at the contract and specification forms in use by our many city, county, state and provincial road departments to realize that the importance of this subject either has not been fully grasped, or, if understood, has been sadly neglected.

The Relations Between Contractor and Engineer

The relations between the road department and the paving contractor are no different than those existing between any other buyer and seller. Their interests are diametrically opposed. The main reason a contractor builds a road is for the profit there is in it. With him, use is a secondary matter, in which, if he is in the better class of his calling, he is mildly interested. Where road paving is done on a strictly competitive basis, no matter how high a contractor's ideals may be, or how much secondary pleasure he might be able to get out of doing a good piece of work, the least that the road department can be induced to accept is the most that any contractor can afford to give. After all, the standard of road construction in any community is not so much the letter of the contract as the interpretation of it that the road authorities are accustomed to permit in actual practice. A well drawn contract and specification is a prime necessity, of course; but with it, competent supervision and careful inspection are also indispensable to good results.

Nothing in this is intended in any way as an aspersion upon contractors. They are quite as human as other people, and equally governed by their practical necessities. In justice to them and to the public alike, a better understanding between the contractor and the road department is essential if we are to get the best results obtainable through the contract system. Fully realizing that the basis of the contractors' relations to the road departments is the contract they sign and the specification for the work that accompanies it, any forward step looking to the improvement of these documents by making them more practical and definite will meet with very general support from at least the better element in the road building fraternity.

Contract an Agreement Between Equal Parties

In the first place, the contract should be in the nature of an agreement between equals; one of whom is ready and willing to deliver the goods specified; the other, ready and willing to pay the price stipulated. Many, in fact, most of the paving contracts, more nearly resemble a master-and-slave contract. Now such a condition of affairs is obviously not conducive to the best results in road building. While it is true that the interests of the contractor and the interests represented by the engineer are opposed in the major premise, there is no reason why both parties should not candidly recognize this fact, and then go ahead, with the least friction possible, to the building of a good road. One of the prime necessities of team work between engineer and contractor is that each thoroughly understand and respect the rights of the other. As a basis for this, there must be the well drawn and easily understood contract and specification in which what each party has agreed to do is clearly stated.

The Contract Fair; the Specifications Clear

In many contracts, it is stated that certain things must be done when the engineer has no intention at all of demanding them, and other things are expressly prohibited that in practice the engineer will quite properly permit. Such a contract is not fair to the contractor. What is necessary should be stated; what is not necessary should be omitted. The requirement for planking a concrete foundation to haul upon it after it has been down seven days is such an instance. Few engineers enforce this clause; and if one did, I should be very suspicious of the quality of his concrete.

In drawing the specification, the rule should be: A reason for everything, and everything in its place. Can engineers much longer go on specifying things that they do not understand? The unfortunate attitude of many public bodies in thinking that, because they have hired a man who is a graduate engineer, he should be able to solve every problem submitted to him without special assistance, is the cause of more poorly drawn specifications than anything else. I have sometimes noticed that the smaller the salary an engineer receives, the more he is expected to know.

Engineer to Guarantee; Not the Contractor

As paving engineers, why do we ask a contractor to guarantee the work that we design, direct and inspect? We tell the contractor what to do, how to do it, and when. If the pavement goes wrong—barring absolute fraud, of course—why should the contractor pay the penalty? Fair play demands that the engineer guarantee his own road. I do not mean to actually suggest that he be asked to give bond and make good the loss, but that the contractor should not be required to make good a failure if it is in no way his fault. The engineer's reputation should suffer; not the contractor's pocket, and through him, the public's. If this rule held true, engineers would be much more careful in the paving work that they specified and constructed.

The practice of requiring a five or ten year guarantee on paving work has done much harm in the past, and will probably live enough longer to do more harm in the future. It has been the excuse offered by innumerable city officials for not bothering about good inspection and careful testing of materials; and it has been productive of more expensive law suits between city and county governments and contractors than any other one item.

Testing and Inspection a Sound Investment

If the money paid for guarantees to contractors, and, through them, to the bonding companies, should be put into the actual road work in the form of careful testing and inspection, the yield from the investment would on the whole be much greater and far more satisfying. Why be content with the five-year guarantee of a pavement on a street where that type of pavement should last twenty-five years; and on heavy traffic roads and streets, why force the contractor into the position of a gambler? Now it sometimes happens that good construction of some type costs no more than the poor constructions that are permitted where there is not sufficient inspection and testing and no one in consultation who is possessed of the special knowledge required to differentiate.

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* Director of Paving Dept., Milton Hersey Co. Limited, before Canadian and International Good Road Congress (Abstracted).

Testing alone is not sufficient. Many can make the bare tests more or less well who do not recognize the significance of the results after they have got them, and who do not know how to go about correcting the defects indicated by the tests. To be of certain value, the scientific work should begin with a study of the sources of supply of the materials, the costs of securing them, their proper selection and combination regulated by field tests, and the final laboratory analyzing and testing of the finished product as a check upon the practical work that has been done in the field. Only in this way can a road department be certain that it is not squandering the public funds in undergrade work.

Road Planning More Important Than Construction

By Thos Adams*

THE direct and indirect loss due to bad planning of roads can be, and probably is, much greater than that which may be due to unscientific construction. Bad planning of a highway system has the effect of increasing costs due to haulage up steep grades and over greater length than is necessary. It causes roads to be laid over hills and across muskegs, creating difficulties in connection with land development and drainage of the worst kind. It has the effect of scattering the population, so that the amount of road surface to be made is entirely out of proportion to that which can be paid for out of any reasonable tax on the people or on the land served by the roads. For the latter reason it causes local authorities to leave roads unmade or to accept the most primitive forms of construction.

Waste in Road Space

Roads should be designed by engineers to save waste in road space as well as in road construction. Above all else our highway policy should be designed to secure the principle of the maximum of convenience at the minimum of expenditure. The real trouble is not the want of public spirit, but simply the want of the available cash to construct roads according to our expensive and wasteful system of planning them. As a matter of fact, we do not plan them; we fit them in somehow into a system of rectangular sub-divisions—either along the concession line or on a five per cent. basis, which is little better. We should learn to plan our roads for a purpose. Primarily, they are for the purposes of providing access to property, means of developing land, and means of communication for carrying on our industries.

Our roads in Canada are of too great a length, too great a width, and there are too many of them in proportion to the tax-paying capacity of the people, outside of the most thickly populated parts of the country.

Fifty-Year Bonds for a Ten-Year Road Unwise

The only sound principle in financing road improvements is to pay for all construction over the period during which it lasts, and only to borrow money for any longer period, say up to fifty years, in respect of such portion of the work as is permanent. This permanent portion consists of the matters which may be described as incidental to the planning of the roads, such as improving the grades by excavation and filling, acquiring a comprehensive survey of every part of a road system before large expenditure is incurred.

The rectangular layout of land, in Canada, is entirely meaningless from any other purpose than that of securing accurate measurement of the land, for which purpose it is well adapted. Human necessity, the traffic requirements of the whole population and the relative cost of development to the value of the land and other property developed, should be the guiding principle in laying out a system of roads and streets. Considering the enormous expenditures required to be incurred to improve roads, their economic and social value, the importance of directness of route, the danger and inconvenience of sharp curves and the advantage of easy grades, it is extraordinary that our stereotyped rectangular system pays no respect to either of these questions, except insofar as it does so by accident.

Well Planned Roads Have Practical Value

Badly located and badly laid roads are a constant tax on any community. We all recognize that well planned and well made roads would help to build up manufacturing industries, cheapen production and reduce the cost of living by bringing the farmer nearer the consumer. Incidentally it would make it easier for the motorist to get about the country, but he is only a secondary consideration. Good roads would also attract settlers to areas that must remain unsettled without them. But in order to get good roads within the paying capacity of the people we will have to be less extravagant in regard to the width of all secondary roads; and in order to be more liberal in regard to width of the main thoroughfares we will have to be less wasteful in regard to second and third class roads and streets. We simply cannot raise the money to make our present road and street system efficient, and the 66 ft. minimum in this province is an economic absurdity. When we lay out roads we should do so on a practical basis.

Land Put to Best Use

Roads should be planned, designed and constructed, as a rule, to suit the particular form of land de velopment to be served by them. They should be made with due regard to the best use to which the land can be put. Provincial aid should be confined to improving the principal lines of communication. The system of planning highways in country districts determines the street system of the city; but we do not attempt to designing the one to consider its effect on the other.

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* Before Canadian and International Good Roads Congress (Abstract)

Prosperity Depends on Road Planning

Until we have a properly planned system of highways adapted for all purposes, and economically sound, we will not be able to deal effectively with bad land development in town and country, and we will only be able to go on dealing with the improvement of roads in a sporadic and haphazard manner—good enough in its way and a satisfactory advance on the past, but far short of the ideal which we should seek to attain, and costly and wasteful in the extreme. It is more correct to say that rural prosperity and increased production depend on a sound economic system of road planning than to say that those things depend on good road construction, for the simple reason that good road construction can only be widely applied if we alter our system of planning.

Excess Water Injurious to Concrete

EXCESS water has a very injurious effect in the manufacture of concrete and the greatest improvement that can be made in present methods will come from a better appreciation of the dangers resulting from a too wet mix. In the "Concrete Highway Magazine," published by the Portland Cement Association, Prof. Duff A. Abrams outlines the evils of excess water and suggests the remedy. His article follows:—

Experience has indicated about what proportion of cement and aggregate must be used to give concrete of the necessary resistance for a given purpose, but little attention has been given to the inter-relation of the effects of varying quantities of water on the resistance of the concrete.

A thorough investigation of this subject is in progress at the Structural Materials Research Laboratory, Lewis Institute, Chicago. These tests have shown the following relations to obtain:

1. With a certain aggregate of the same grading and sufficient water to produce a concrete of a given plasticity, the strength of the concrete, within the usual range of mixes, is proportional to the quantity of cement in a unit volume of concrete.

2. With a given aggregate and the same quantity of cement, the strength of the concrete is a maximum with the smallest quantity of water which can be used to produce a plastic mix; any increase in the quantity of water is accompanied by a very rapid falling off in the strength of the concrete.

3. With a given aggregate mixture, the same quantity of cement, and sufficient water to produce a concrete of definite plasticity, (a) the strength of the concrete increases with the "coarseness" of the aggregate up to a certain limit; (b) this limit of "coarseness" is higher for a larger quantity of cement and lower for a smaller quantity of cement; (c) the limit of "coarseness" of the aggregate which it is feasible to use varies slightly with the character of the material, being somewhat lower for a mixture of sand and crushed stone than for sand and well-rounded pebbles, and lower still for mixtures in which crushed stone or similar material is used as fine aggregate.

4. For given proportions of cement and aggregate the quantity of water required for a definite plasticity depends largely on the grading of the aggregate and to only a minor degree on the character of the material, shape of particles, etc.

5. For a given aggregate, the quantity of water required to give concrete of the same relative plasticity is directly proportional to the quantity of cement.

Too Much Water Used

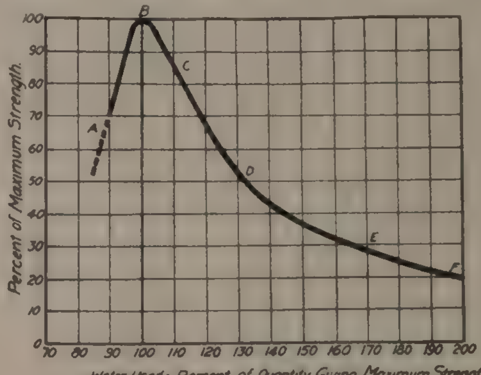
If we assume that concrete materials of suitable character are at hand, and that mixing and other details are properly cared for, the engineer generally has the following alternatives for improving the quality of the concrete:

(a) More cement.

(b) Coarser aggregate (within certain limits).

(c) Less water (limited by the necessity of producing a plastic mix).

Economy dictates the use of the smallest quantity of cement which will produce concrete of the desired resistance. The tendency has been during recent years to use entirely too much water; in many instances the water used is 50 to 100 per cent. in excess of the quantity which gives the highest strength, resulting in concrete of not more than 25 to 50 per cent. the strength that should have been obtained with the same cement and aggregate and a proper quantity of water. While some sacrifice in strength is generally necessary in order to secure concrete which may be handled and placed at low cost, it is absurd to sacrifice 50 to 75 per cent. of the strength which is practically available in this way. While the injurious effect of excess water in concrete has been given little attention, a great deal of emphasis has been placed on the benefits to be derived from the use of coarse, well-graded aggregate.



Strength is affected by amount of water

The experimental work referred to above has already thrown much new light on the subject. We are forced to the conclusion that the chief advantages of well-graded and coarse aggregate as compared with poorly-graded aggregate comes from the fact that the concrete can be mixed to a workable plasticity with less water, and not to any inherent difference in the behavior of aggregate of different sizes. In other words, while coarse, well-graded aggregate is highly desirable, little or nothing is gained by using aggregates of the highest grade unless we take advantage of the fact that it can be mixed with correspondingly less water. This makes it apparent that many of the shortcomings of concrete made of fine or poorly-graded aggregate should be charged to the additional water required to mix the concrete.

Limit to Quantity of Water

It is as important that an upper limit be placed on the quantity of water as it is that a lower limit be placed on the quantity of cement in the batch. It would be just as consistent to specify the quantity of aggregate and water and leave the proportioning of the cement to the judgment of the mixer foreman, as to specify the quantity of cement and aggregate and leave the proportioning of the water to the mixer gang. Exactly the same effect is produced by the use of an excess of water as by a deficiency in cement; and it is more important now that special attention be given to the water in concrete, since the present methods give reasonable assurance that the proper quantity of concrete is used.

All the benefits which may arise from using good cement, coarse, well-graded aggregates, thoroughly mixing the concrete, etc., are completely nullified if an excess of water is used in the mix.

The diagram summarizes the results of compression tests on 6 x 12-in. concrete cylinders made in mixes ranging from one part cement and nine parts aggregate to one part cement and two parts aggregate by volume. These mixes represent concretes of all qualities from the leanest to the richest which are generally used for any purpose. The aggregate consisted of a mixture of sand and pebbles graded in size from the finest particles up to 1¼ inch; exactly the same grading was used in all cases.

These tests show that the effect of proportional changes in the mixing water is approximately the same for all mixes of concrete; consequently a composite curve has been drawn to show the average effect. The vertical distances represent the relative strength of concrete, expressed as a per cent. of the maximum which can be secured from a given amount of cement and the same aggregates. The horizontal distances indicate the relative quantity of water used in the mix, considering the amount which gives the maximum strength as 100 per cent.

The amount of water which gives the maximum strength in concrete produces a mix which is too stiff for most purposes. In plants where such products as building units, drain tile, sewer pipe, etc., are manufactured it is desirable to use a mix even drier than that which gives the maximum strength. The molds can thus be removed within a short time; this would be impossible if a wetter and more plastic mix were used.

It will be noted that the concrete strength increases rapidly with the quantity of water over the range indicated by A-B on the diagram. With any further increase in the amount of water there is a rapid falling off in strength, as indicated by the curve BCDEF. With an amount of water about double that required for highest strength, the concrete has only about 20 per cent. of the maximum strength.

The exact amount of water corresponding to the maximum strength of concrete will vary with the method of handling and placing the concrete. Any method which involves puddling, tamping, rolling, or vibration, or the exertion of pressure in any manner, will have a tendency to increase the strength of the concrete, regardless of the amount of water used. However, it is probable that the effect produced by these methods will be more pronounced in the consistencies in the vicinity of the maximum strength.

"In mixing concrete use the least quantity of water that will produce a workable mix, then give the concrete as much water as possible after it has begun to harden," is the only safe rule to follow. The amount of water which should be used with given materials cannot always be determined in advance; it will also vary with the nature and size of the work. However, every effort should be made to keep the water content of the concrete at a minimum. It is not feasible to use the quantity of water corresponding to the highest possible strength of concrete (a similar statement may be made with reference to the "coarseness" of the aggregate), yet this difference should be reduced to a minimum by using the smallest practicable amount of water.

The abuse of the water element in concrete has come about solely from the fact that it is cheap, and frequently facilitates handling and placing. Much of the concrete which is being made at the present time could be greatly improved, at no additional cost, if the owner were compelled to pay, say, ½ to 1 cent per gallon for all water going into the mixer. In many respects it is unfortunate that water is not an essential element in the cost of concrete.

Probably the greatest improvement which can be made in our present methods of manufacturing concrete will come from a better understanding of the very injurious effect of excess water and a saner practice in proportioning this important element of the mix.

Ultra Violet Rays for Water Purification

THE employment of ultra violet rays, at the present time, is receiving considerable application in furnishing treated water for drinking purposes, in bottling works, in the sanitation of swimming pools and for the use of armies in the field. In France the method is said to be successfully applied to the treatment of municipal water supplies. Tests of ultra violet ray apparatus were conducted recently by Mr. R. R. Spencer, Assistant Surgeon, U. S. Public Health Service, Chicago. The results of these tests were given by Mr. Spencer in a paper presented at the annual meeting of the Illinois Section of the American Water Works Association, from which the matter that follows is taken:

A gravity and a pressure type of mercury vapor arc lamp apparatus were tested. In the gravity type the lamp is suspended in a baffled treatment chamber a few inches above the surface of the water, which in a thin film is exposed twice during its passage by the lamp. This type is operated at 110 volts and has a rated capacity of 120 gallons per hour.

The pressure type consists of a cast iron cylindrical shell with a quartz tube through its axis and containing an arrangement of baffled plates for the same purpose as those in the gravity type. The lamp is inserted within the axial quartz tube. A 220-volt lamp is required to produce a sufficient amount of ultra violet rays for treating 750 gallons of water per hour, the rated capacity.

Usually a fluctuation in voltage of 10 per cent. or over is sufficient to extinguish the light. To prevent the passage of untreated water, each apparatus is provided with an automatic electrical arrangement controlling valves which will prevent the flow of water until the temperature of the lamp has risen sufficiently to produce an abundance of ultra violet rays and which will cut it off when for any reason the light goes out.

Each apparatus was operated in connection with a rapid sand pressure filter which clarified the water just before it entered the light chamber. It was at this point that all the raw water control samples were taken. In order to artificially contaminate the water the alum shunt-feed box on the filter was kept filled with rich broth cultures of B. coli and other bacteria. By this means enormous quantities of all kinds of organisms could be fed to the filter, which allowed nearly all to pass through to the ultra violet ray apparatus after the sand bed had once become thoroughly saturated with them. The raw water contained many more times B. coli than one ever finds in the worst drinking water.

The vast majority of all samples were collected while the apparatus was being operated in excess of its rated capacity.

Small Gravity Type Apparatus

(Capacity, 120 gal. per hour)

The following table includes a total of 142 samples, taken on 17 different days during a period of two months:

No. and kind of sample	Average total count per cc. on Agar at 37 degs. C.	Average number of B. coli
33 raw water	29,400	3,256 in 1 cc.
109 treated water	12	1 B. coli in 15 c.c.

86 of 109 treated samples gave 0 B. coli in 50 c.c.
10 of 109 treated samples gave 1 B. coli in 50 c.c.
2 of 109 treated samples gave 2 B. coli in 50 c.c.
2 of 109 treated samples gave 3 B. coli in 50 c.c.
1 of 109 treated samples gave 4 B. coli in 50 c.c.
1 of 109 treated samples gave 5 B. coli in 50 c.c.
*7 of 109 treated samples gave 50 B. coli in 50 c.c.

*The last seven samples showing 50 B. coli in 50 c.c. were taken after the machine had been idle for one month and the raw water controls at the same time had at least 100,000 B. coli per c.c. and a total count of 150,000. If these seven samples are eliminated in figuring the average number of B. coli in the treated water, there would be only one B. coli in 175 c.c. instead of one in 15 c.c. as shown in the table.

Large Pressure Type Apparatus

(Capacity, 750 gal. per hour)

The following table includes a total of 330 samples, taken on 29 different days during a period of two months:

No. and kind of sample.	Average total count per c.c. on Agar at 37 degs. C.	Average number of B. coli
48 raw water	3,900	2,630 in 1 c.c.
282 treated water	7	1 B. coli in 103 c.c.

211 of 282 treated samples gave 0 B. coli in 50 c.c.
31 of 282 treated samples gave 1 B. coli in 50 c.c.
21 of 282 treated samples gave 2 B. coli in 50 c.c.
14 of 282 treated samples gave 3 B. coli in 50 c.c.
3 of 282 treated samples gave 4 B. coli in 50 c.c.
2 of 282 treated samples gave 5 B. coli in 50 c.c.

The bacteriological tests were performed, with slight exception, in accordance with the Standard Methods of Water Analysis of the American Public Health Association. The fermentation of lactose broth and the characteristic appearance of Endo was considered sufficient identification of B. coli.

A total of 391 treated samples were tested. Of these 53, or 13.5 per cent. did not come within the U. S. Treasury Department standard of permissible impurity, which requires that not more than one of five 10 c.c. portion of each sample shall show the presence of organisms of the B. coli group. This appears to be a poor showing. However, it cannot be so considered when a comparison is made with the extremely polluted raw water control samples collected at the same time.

In the gravity type of apparatus 86 of 109 treated samples, or 78.8 per cent., showed no organisms of the B. Coli group in 50 c.c., while the untreated water contained an average of 3,256 B. coli per cubic centimeter.

In the pressure type 211 of 282 treated samples, or 74.8 per cent., gave no B. coli in 50 c.c., while the untreated water was yielding 2,630 B. coli in 1 cubic centimeter. The great reduction is the more remarkable when one considers the actual time of exposure of the water to the rays is approximately 64 seconds in the large and 30 seconds in the small apparatus, when they are running at their normal rate.

The fact that spore-bearing organisms are somewhat more resistant to those rays than vegetative forms has been shown. In the above outlined tests the lactose broth tubes would frequently show fermentation at the end of 48 hours. In such cases transfers invariably proved negative on Endo for B. coli. The organism that caused this result proved to be a strict anaerobe and was later identified as belonging to the B. Welchi group. It is believed that the appearance of such organisms in water is not of sanitary significance.

Conclusions

The use of ultra violet rays in the purification of drinking water is relatively a recent procedure, and it is believed that the method is capable of further development, with a corresponding increase in efficiency. The method is especially recommended for treating water in circulating systems, in which the water may be exposed many times to the ultra violet rays. Such systems are now used for disinfecting water in swimming pools, hotels, industrial and other institutions. The chief advantage of this method of treatment over chemical methods lies in the fact that objectionable overdosage is impossible. Again, from the standpoint of potability, the water is absolutely unchanged, and hence in this respect is superior even to boiled water.

The present forms of apparatus need considerable attention when in operation. Care should be taken to prevent an accumulation of grease or dirt of any kind on the quartz tube. Experience has shown that a very small amount of grease will obstruct the light sufficiently to allow many organisms to pass. Furthermore, the light chamber should be emptied if the machine remains idle for any length of time. This will prevent the growth of algae and other organisms which will obstruct the light when the machine is operated. There is no way to determine when the lamp fails to emit a sufficient amount of ultra violet rays to give a satisfactory water, except by collecting samples and testing the treated water frequently. Theoretically, as long as the lamp remains intact and the vacuum holds, no reduction in the amount of ultra violet emanation occurs. It is stated by the manufacturers that a lamp will wear out before its efficiency noticeably decreases. The proper construction of the lamp is of great importance, and considerable variations have been noted between individual lamps.

In regard to cost, the method is not expensive when treating quantities of water of 30,000 gallons or less per twenty-four hours. For municipal supplies, using several million gallons per day, the expense is considerable, and probably prohibitive.

Inspection of Galt Steel Bridges Shows Heavy Rust Deterioration

AT the request of the Board of Works of Galt, Ont., Mr. E. H. Darling, M.E., A. M. Can. Soc. the Hamilton Bridge Company, recently made C. E., of Hamilton, formerly chief engineer of an inspection of the Queen and Concession street bridges as to their safety, and has submitted a report. He states that the steel work of these bridges has been so neglected that almost the entire surface is covered with scales of rust, and at the points where the end posts of the spans pass through the floor a very appreciable percentage of the steel has rusted away. He also discovered many bent, loose, and misplaced rods and other minor defects, and his calculation was that the steel work of these bridges had deteriorated at least 25 per cent. The wood floor on the Queen Street bridge was also in a very bad state, and the strength of the joists very uncertain. If the bad spots in the floor were patched up it would be safe to allow light vehicular traffic on the bridge until a new floor could be laid, but at present it should be closed to all heavy loads. The floor of the Concession Street bridge was not so bad, but very heavy loads should not be allowed on it, either. On investigating the strength of these bridges he had come to the conclusion that it would not be advisable to put concrete floors on them, for the following reasons:

1. The margin of strength, even if the bridges were in perfect condition, is not sufficient, considering their location and the traffic over them.

2. The floor would have to be of light construction, using steel joist, and therefore expensive at this time.

3. A good floor would outlive the trusses and would have to be "scrapped" before it was worn out.

4. Before any money is invested in permanent construction the bridges should be raised as high as possible to avoid danger from ice.

Mr. Darling made the following recommendations regarding the repair of the bridges, provided it was not found economical to consider new bridges:

1. That the present floors be taken off and the entire surface of the steel work be thoroughly cleaned by means of sand blast or by wire scrapers.

2. That all bent and loose rods be adjusted and all other defects be repaired.

3. That the end posts of each span be embedded in concrete up to one foot above the level of the floor, with two inches of concrete. Care must be taken not to interfere with the expansion of the bridge. This concrete will not only stop further rust at these points, but will strengthen the members where they have rusted away.

4. The entire surface of the steel work should then be given two good coats of paint.

5. Lay a new wood floor of the same size of lumber as is in the floor at present. All timber should be either treated with creosote or kyanized, as the longer life would more than pay for the extra cost.

6. The bridges should be gone over every year and any signs of rust cleaned off and painted. In two years' time all exposed surfaces should be given another coat of paint, and in the future they should be painted regularly every three or four years, or, in any event, before the rusting starts.

Mr. Darling stated, however, that he believed the outlay for this work would go a long way towards paying interest charges on the cost of new reinforced concrete structures, built on the existing piers, and suggested that a rough estimate be made out before the Council should commit itself to any expenditure.

Industrial Development Memorandum Sent to C. S. C. E. Members

THE Canadian Society of Civil Engineers are issuing to the members a copy of the memorandum regarding national industrial development in Canada, prepared by Sir Charles Ross, member of the American Society of Mechanical Engineers, and Messrs. R. A. Ross, C. H. McLeod, Walter J. Francis, and H. R. Safford, members of the Canadian Society of Civil Engineers. This memorandum is a plea for the constitution, by the government, of a permanent consulting board, selected from the engineering and scientific societies of Canada. The memorandum is accompanied by a circular drawing attention to the importance of industrial preparedness and of the facts contained in the memorandum.

Brick Concern Changes Management

At the annual meeting of the National Brick Company of Laprairie, Ltd., held in Montreal, some changes in the personnel of the management were made. Mr. A. A. Ayer was elected president, in succession to Mr. J. N. Greenshields, who still retains his seat on the board; Mr. R. M. Ballantyne was made vice-chairman, while Mr. H. R. Trenholme was appointed managing director. Mr. A. T. Alexander is secretary-treasurer, succeeding Mr. P. S. McKergow, who recently resigned to become head of the Mack Brick Company, Ltd., a concern which will open a new brickyard at Laprairie. The report of the National Company shows net profits of $42,714, as compared with an operating loss of $63,170, in the previous year. The sum of $20,000 is transferred to a new reserve for plant renewal, and the balance is carried to profit and loss.

Abrasive Company Establishing Canadian Plant

The National Abrasive Company, of Boston and Amesbury, Mass., manufacturers of carbolon, an abrasive material for grinding and polishing purposes, have decided to locate in Hamilton, and have bought an acre and a half of land on Biggar Avenue, near Lottridge Street. They will start erecting a factory immediately, and expect to start operations in ninety days, and at the start will employ about 75 men. The equipment and material is being ordered through the Ritchey Supply Company, of Toronto, who are the selling agents for this company in Canada. Nathan C. Harrison, treasurer of the Harrison Supply Company, through which concern they market their products in the United States, is also president of the National Abrasive Company. He has connected with him J. T. Johnston, who is looking after the erecting and equipping of the Hamilton factory.

Mr. A. F. Macallum, M. Can. Soc. C. E., Commissioner of Works, Ottawa, addressed the Ottawa Branch, C.S.C.E., on Thursday, April 12, on "Municipal Engineering," dealing particularly with the problems of the capital city.

Practical Hints for the Contractor

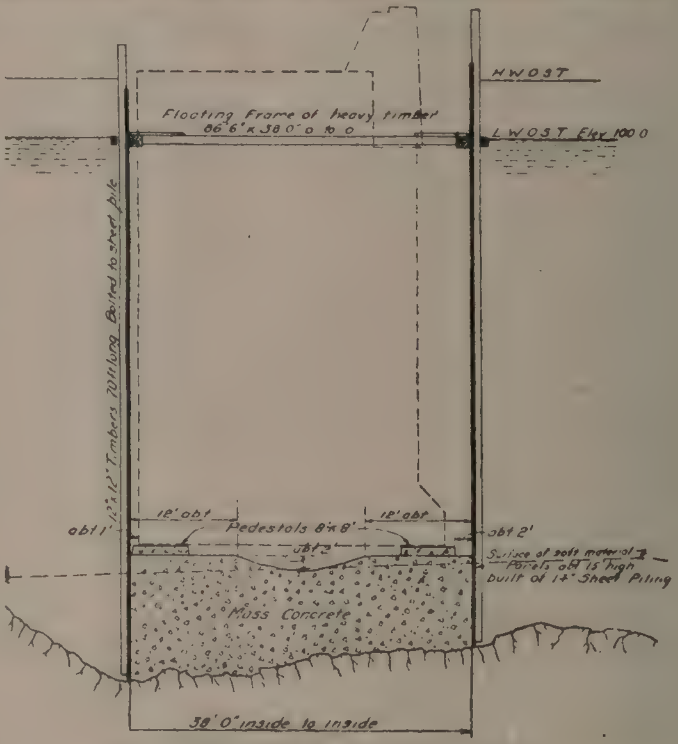
that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Deep Water Foundations at Halifax Ocean Terminals Constructed in Special Forms

By A. C. Brown, A.M. Can. Soc. C.E.

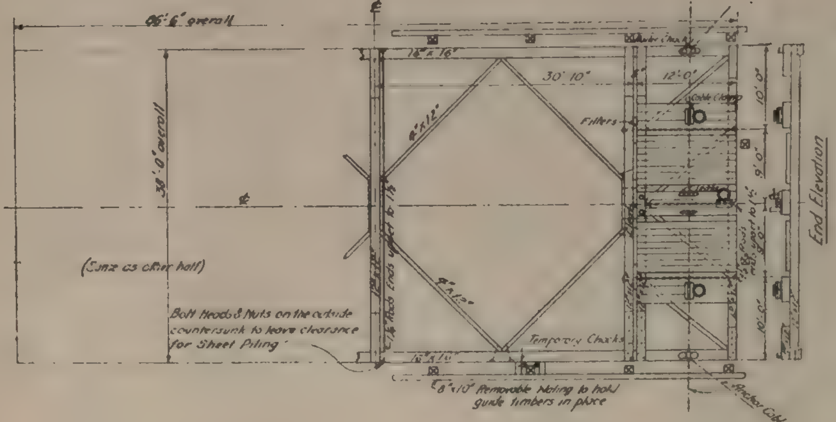
An article in the Contract Record of September 27, 1916, page 932, presented a description of the Halifax Ocean Terminals, now in course of construction. As indicated, the quay walls are built of stacks or tiers of cellular reinforced concrete blocks, each measuring, in average cases, 31 ft. x 21 ft. 10 in. x 4 ft. 4½ in., and containing 15 cells. They are placed one above the other and securely bonded and bedded by means of mass concrete and broken rock in the cellular compartments. A quay wall from foundation to 14 ft. 6 in. above low-water level is thus built up. The bottom blocks are set on concrete pedestals placed on the foundation rock, these pedestals being 5 ft. x 6 ft. in area, and from a few inches to several feet in depth. They are placed every 22 ft. along the line of the wall, and upon them the bottom blocks are placed, with the adjacent corners of successive stacks resting on the same pedestals. When they are more than 4 in. deep they are connected by a concrete wall about 2 ft. thick at the top, which is left 3 in. lower than the pedestal.

The preparation of the foundations is a problem in itself, inasmuch as most of the walls are founded on rock which is often 60 ft. or more below low-water level. The grade for the quay walls is 45 ft. below low-water level, this being the designed clear vessel draft. Rock above grade is excavated by dredges, and pedestals are built by means of a large diving bell. Where a rock is encountered below or within 10 ft. of the bottom block level a massed concrete foundation is used, for which a specially-designed form is employed as described and illustrated in this article.

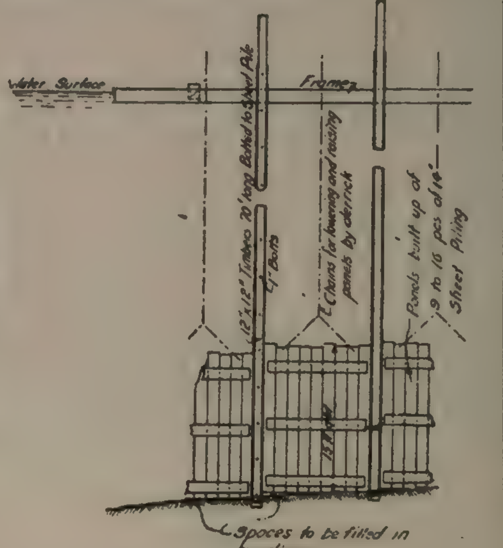

HWOST
Floating Frame of heavy timber 86'6" x 38'0" o to o
LWOST Elev 100.0
12"x12" Timbers 70 ft long Bolted to sheet pile
12' abt
12' abt
abt 1'
Pedestals 8'x8'
abt 2'
abt 2'
Surface of soft material
Panels abt 15' high built of 14" Sheet Piling
Mass Concrete
38'0" inside to inside

Cross-section of deep water foundation and form.

The soft materials overlying are removed by floating orange-peel dredges, and the rock left clean but serrated with a slight general slope down from the front to back of the wall, after which the foundation is care-



Plan of frame for placing deep water foundations at Halifax terminals.


Water Surface
Frame
12"x12" Timbers 70' long Bolted to Sheet Pile
1" Bolts
Chains for lowering and raising panels by derrick
Panels built up of 9 to 16 pcs of 14" Sheet Piling
15' 0"
Spaces to be filled in by diver.

Side elevation of frame.

fully cleaned with a water jet, small clam shell, and helmet divers.

The illustrations show the details of the specially-designed form used to construct the concrete base. It consists of panels of interlocking steel sheet piling 15 ft. long and 16 ft. high, with long piles every 15 ft., fastened to a 16 x 16 timber about 20 ft. long. The long piles come to the surface of the water and are held at their tops by a floating timber frame moored in position. This forms on the bottom of the harbor a box 75 ft. long and 39 ft. wide, 39 ft. being the width of the concrete foundation. Three of these forms are in use, and over 1,300 ft. of massed concrete foundation have been put in by means of them and give every satisfaction.

The concrete is put in from a floating one cubic yard concrete mixer by means of a one cubic yard bottom dumping bucket which cannot dump until it is on the bottom. Concreting proceeds day and night until the section under construction is completed, and is carried through in from 3 to 5 feet lifts, depending on the depths of the foundation. Beach gravel is employed as aggregate, and a 1:2½:5 mix of concrete is used.

The concrete is brought up to a level of from 6 in. to 1 ft. below the bottom of the block work, with a depression of 2 ft. deep in the middle for bond. After 24 hours the concrete pedestals are set by helmet divers. In order to place these, timbers as fastened to the long piles above water across the foundations, at right angles. From these timbers are suspended iron pipes back and front of each pedestal. The top surface of the pipes are set at the required level, and the piping then carefully blocked up in place by divers. Around the outside edges of the pedestals are placed bags of concrete to act as forms and prevent the edges of the pedestals from washing away.

A very wet massed concrete is then deposited by means of a bottom dump bucket between the bags and carefully screeded off to the level of the pipes by divers using an iron rod. This method of setting pedestals has proved to be perfectly satisfactory, and the block work set on these has, when completed, been very accurate as regards line and level. One diver can make three of these pedestals in a day under favorable conditions.

Regina Branch C.S.C.E. Deplores Employment of Alien Engineers

At the last regular monthly meeting of fthe Regina branch of the Canadian Society of Civil Engineers it was unanimously decided to support the proposal of the council of the parent body in Montreal to present a memorial to Premier Borden on his return to Canada showing the number of large and important Canadian engineering works which have been handled by alien engineers.

Following this a discussion on W. F. Tye's paper, "Canada's Railway Problem and Its Solution," read before the parent body in Montreal, arose. It was thought by those in attendance that the engineering profession throughout the Dominion did not express its opinion strongly enough on the difficulties of the railway problem facing Canada. It was decided to call a special meeting of the Regina branch to read Mr. Tye's paper and discuss it thoroughly. It was also decided to invite representatives of the Provincial Government and other public bodies to take part in the discussion of this paper, and make public the opinion of Saskatchewan engineers.

Mr. N. Warren, of the Dominion Bridge Company, who was present at the disaster of the Quebec bridge last year, when the central span collapsed and went to the bottom of the St. Lawrence, attended the meeting and gave a few details of the accident.

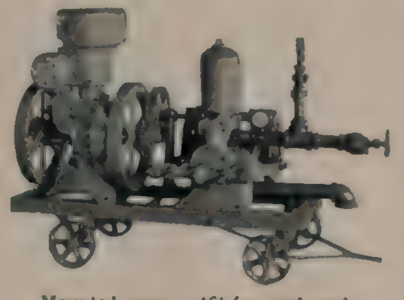
The evening was concluded by an interesting paper read by C. S. Cameron on "Drainage Problems in Saskatchewan."

Engineers Decorated for Bravery

Additional names of Canadian Society of Civil Engineers members decorated for conspicuous bravery under fire have been received. The list now numbers 39, some of the members having received more than one decoration.

A Portable High Pressure Road Pump

A new light, high-pressure pump delivering 33 gallons per minute under a head of 270 feet, has been put on the market for use in construction road work. For this purpose it is mounted as shown in the photograph. At capacities of from 32 to 110 gallons per minute it is claimed it will deliver water a distance of three miles. The valves are of the spinning type, self-cleaning and self-grinding. It is a single cylinder, double-acting pump, built in six sizes, varying from 3 x 5 in. to 6 x 6 in. The weight of the 5 x 5-in. size, with 3 h.p. engine, is 1,100 pounds. The outfit is built by the Whitman Agricultural Company.


Mounted pump outfit for road work.

Mr. J. Oscar Benoit, formerly general sales manager of the St. Lawrence Brick Company, Montreal, has joined the sales staff of Hyde & Sons, Ltd., Montreal. The latter company are removing to the New Birks Building, Montreal.

New Books

"The Engineering Manual," by Ralph G. Hudson, S.B., assistant professor of electrical engineering at the Massachusetts Institute of Technology and Harvard University. John Wiley & Sons, 432 Fourth Avenue, New York, publishers. This book is based upon the conception that the practising engineer or engineering student would welcome a consolidation of the formulae and constants for which he is accustomed to search through several volumes, and that the application of each formula might be explained in more concise form than in texts devoted exclusively to the process of derivation. With this end in view, those engineering formulae, mathematical operations, and tables of constants which appear to be most useful are presented in systematic order. Pocket size; limp covers; 310 pages; price, $2

The Spraco Cooling System

DURING the summer of 1914 the Spray Engineering Company, of Boston, Mass., installed one of their Spraco cooling systems in connection with an installation of Canadian General Electric steam turbo-generators at the Bennett Avenue plant of the United Last Company, Ltd., Maisonneuve, P.Q. This installation consists of a concrete pond 64 feet long by 45 feet wide, inside measurements, surrounded by a louvre fence, and having 42-inch bronze turbine spray nozzles, with a total capacity of 1,600 gallons per minute, arranged in connection with a piping system over the pond. The entire work, including excavation, pouring of concrete bottom and side walls, as well as piers for supporting suction well, necessary expansion joints, erection of fence and pipe with special equipment was carried on completely by the Spray Engineering Company, under charge of one of their erecting engineers.

The forty nozzles were arranged in eight groups of five each by means of the special spray heads and spray arms used by the company in their standard installations. The bottom slab of the pond was six inches in thickness, sloping towards the suction well. The depth of water in the pond varied from three feet at the suction well to two and one-half feet at the opposite end of the pond. The pressure carried at the nozzles varies from between six pounds and seven pounds during hot weather to considerably less than four pounds during winter weather.

Although this company had operated a number of ponds in the New England States during the previous four years, with no difficulty from freezing during extremely cold weather, still, the temperature never went below 15 degrees below zero, and, as the temperature of the air in Montreal goes considerably below this point at times, it was thought best to supply a special feature in this case to prevent possible difficulty from formation of anchor ice in the pond around the intake screen when the temperature of the air is in the neighborhood of 30 degrees below zero. Hence a four-inch bleeder was arranged so that it could be opened more or less as required, admitting a small amount of hot water directly from the condenser, thus enabling them to maintain the temperature of the water in the pond between 35 degrees and 40 degrees, no matter how low the temperature of the air might go. This device proved to be very successful, and no difficulty whatever has been experienced from formation of ice in the pond.

Interior view of Spray cooling pond.

After this pond had been in operation two winters and one summer, the United Last Company advised the Spray company that they were able to cool water to a temperature of 80 degrees F. with air at 94 degrees F., and maintain 28-in. vacuum under these conditions, which is a very satisfactory result for both parties concerned. They also stated that there were no leaks in the pond, and that the entire installation had proved to be satisfactory in every way. The Spray Engineering Company now has five or six additional installations in Canada, between 250 and 300 in all parts of the United States, three in Mexico, 35 in Cuba, and one each in Porto Rico, South Africa, and China. The "Spraco" system, as compared with cooling towers, is claimed to require less power, less make-up water, have longer life, and lower first cost. For electrical plants both the air and the water cooling systems of the company appear to have a promising future. The control of generator and motor temperatures working anywhere near capacity requires a very large amount of cool, clean air. The same is true of the water requirements of our larger steam turbines and transformers.

Exterior view of cooling pond.

Mainly Constructional

East and West—From Coast to Coast

The Brick and Tile Supply Company, Ltd., has been incorporated, with a capital of $5,000, head office Ottawa, Ont.

The question of engaging a superintendent for the paving plant at London, Ont., is under consideration by the City Council.

The Pre-Cast Concrete and Supply Company, Ltd., has been incorporated, with a capital of $50,000, head office at Oshawa, Ont.

Mr. F. H. Miller, of Miller & Sons, has announced his intention of building rows of small brick houses suitable for workingmen just beyond the Toronto city limits in Earlscourt, where taxes will be light.

Instructions have been issued by the London and Port Stanley Railway Commission to Engineer Morrison to obtain drawings of the pier and lands at Port Stanley, with a view to having a large new elevator erected as soon as possible.

The Dominion Railway Board has approved of the construction of a subway on St. Paul's Avenue, Brantford, Ont., at the Grand Trunk crossing. It is estimated that an expenditure of $50,000 will be required to carry out this work.

Letters patent have been issued to Halliday Brothers, Ltd., authorizing them to carry on the business of dealers in coal, coke, wood, etc., and builders' supplies. The firm is capitalized at $200,000, and their headquarters will be at Winnipeg.

The Nicholson File Works propose to make considerable additions to their plant at Port Hope, Ont. They request the Town Council to grant them a fixed assessment and build a foot-bridge across the Ganeraska River, on Wright Street, to connect with Martha Street.

It is announced that the National Abrasive Company, of Boston and Amesbury, Mass., will establish a branch in Hamilton, Ont. The firm has a contract for 2,666 horsepower from the local hydro commission and has purchased land on Biggar Avenue, near Lottridge Street.

It is announced that the Canadian and International Good Roads Congress next year will be held at Hamilton, Ont. The convention proper will be held at the Royal Connaught Hotel, but another building will have to be secured for the accommodation of road-making machinery exhibits.

The London and Port Stanley Railway Commission propose to erect a new and up-to-date depot in St. Thomas on the railroad property near Talbot Street. Watt & Blackwell, architects, are authorized to prepare plans and specifications for the construction of the building at the earliest possible date.

The Provincial Highways Commission of Manitoba has approved the construction at Winchester of six bridges at a total cost of $7,000. Road grading in the Woodlands municipality is to be started soon. The contract for the grading of thirty miles was let Simpson & Sheuman and Jones & Jones, the total amounting to $35,000.

Plans for the proposed Beach Avenue sewer, in Vancouver, to be built by the city, at a cost of between $25,000 and $30,000, have been approved by the Vancouver and District Joint Sewerage Board, and the work of building the sewer is to be proceeded with. The sewer will be six feet in diameter, and will run along Beach Avenue, from Morton Avenue to the Park, where it will be connected up with the trunk sewer. The construction of this sewer will result in the removal of the sewer outlet in English Bay, which has been objectionable to bathers.

Despite the war-time prices and the prevailing labor situation, it is stated that considerable building activity may be expected in Hamilton, Ont., this season. A number of apartment houses, public garages, factory extensions, and alterations are being planned. Among the larger structures which it is proposed to erect is a store for Grafton & Co., the cost of which will exceed $100,000, to replace the building destroyed by fire some time ago; also a $100,000 factory to be occupied by the Carbon and Alloy Steels, Ltd., for which plans are being prepared by Prack & Perrine, Toronto. The architect for the former structure is G. J. Hutton.

Work projected by the Toronto Harbor Commission for this year includes the carrying out of substructure work for harbor head walls along the section of the water-front extending from 450 feet east of Spadina Avenue to York Street. This will involve the sinking of about 6,000 feet of cribbing along this section, including two slips for vessels and a part of a third. Last year the substructure for the section between Bathurst Street and Spadina Avenue was put in, the distance being 3,400 feet, and this year the superstructure will be constructed. Next year the superstructure for the portion between Spadina Avenue and York Street is to be placed.

In a report to the City Council, the Board of Works of Sault Ste. Marie, Ont., recommended the following sewer work: An 8-in. sanitary sewer from the centre of Upper Brock and Bay Streets, along Bay Street to Lower Brock Street, and continuing from Bay Street down Lower Brock Street; 8-in. cast iron sewer from water line to new harbor line; 8 in. sewer on Bay Street, from Brock Street to Bell Avenue. They also recommend that the East Street sanitary sewer outlet be extended, and that a sanitary sewer and outlet be built on Pine Street, from Queen Street to the river, and that the 48-inch storm sewer on Elgin Street be not built.

Personal

Brigadier-General F. O. W. Loomis, D.S.O., of D. G. Loomis & Sons, contractors, Montreal, has been awarded the Colonial Officers' Decoration for long service. General Loomis was recently wounded, but has now resumed his duties at the front.

Lieut. Charles S. DeGruchy, B.Sc., Montreal, a junior member of the Canadian Society of Civil Engineers, has been slightly wounded at the front. In February he was awarded the Military Cross. Prior to joining a draft of the field artillery he was assistant engineer at the Hailfax Ocean Terminals.

Obituary

Mr. Gerald Lomer, president of Gerald Lomer, Ltd., Montreal, died suddenly on April 16. Prior to the war the firm did a considerable business in steel pipes and machinery.

Lieut. J. D. Armstrong, of the Topographical Surveys Branch, Department of the Interior, Ottawa, has been killed in action. After graduating from McGill University he was connected with the Grand Trunk Pacific in construction work. He was a student member of the Canadian Society of Civil Engineers.

Mr. James Balfour, a well-known architect of Hamilton, Ont., passed away recently, at the age of 64 years. The late Mr. Balfour was identified with the erection of a large number of the older and larger buildings of Hamilton, amongst them the City Hall, which was erected under his supervision in 1888-89.

Major J. A. DeLancey, B.Sc., reported missing and believed killed, was a member of the firm of Lighthall & DeLancey, Vancouver. He went to the front with a Nova Scotia regiment, was twice wounded, twice mentioned in desatches, and was recently awarded the Military Cross. Major DeLancey was at one time in charge of one of the plants of the Panama Canal. He was an associate member of the Canadian Society of Civil Engineers.

Mr. Henry E. McKenzie, who for many years carried on a prosperous building and contracting business at Estevan, Sask., died recently at Rochester, Minn., following an operation. The late Mr. McKenzie was born at St. Stephens, N.B., thirty-nine years ago. He spent his early manhood in Minneapolis, and went to Estevan about twelve years ago. There he established a successful business, his contracts including many of the larger public buildings in that part of the province.

Lieutenant-Colonel Walter W. Stewart, the well-known architect, of Hamilton, Ont., who went overseas in command of the 86th Machine Gun Battalion, has been reported killed in action. The late Colonel Stewart was born in Covington, Ky., about 46 years ago. As a child he went with his parents to Toronto, and later to Hamilton, where he had since resided. He studied architecture under his father, and later took a course at Cleveland, Ohio, where he graduated. Returning to Hamilton, he entered into partnership with his father, and, upon the latter's death, formed a partnership with W. P. Witton. They planned a number of public schools and other large buildings in Hamilton, among them the new Armories and the Collegiate Institute, and were recognized as one of the city's leading firms of architects.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Amherstburg, Ont.
Town Council plan sewage extension. Chairman, Mayor Park.

Town Council plan waterworks improvements. Chairman, Mayor Park.

Byron, Ont.
Utilities commissioners, City Council, plan waterworks extension costing $5,000. Superintendent, E. V. Buchanan, City Hall.

Hamilton, Ont.
Engineer's report adopted recommending additional steam and electric units, costing $107,000, for Beach pumping station. City Engineer, E. R. Gray.

London, Ont.
City Council plan construction of pavements. Engineer, H. A. Brazier.

Board of Health has ordered sanitary sewer on Maitland Street, and City Council plan to lay same this summer. Engineer, H. A. Brazier.

Merritton, Ont.
Clerk of Town Council, R. Clark, will call tenders shortly for supply of sewer pipe and about 6,000 yards of concrete pavement.

Middleton Township, Ont.
Township Council plan improvements on Mills and South Norwich drains. Clerk, D. W. White, Courtland.

North Norwich Township, Ont.
By-law passed for construction of Linart drain. Council also plan to repair township roads. Clerk, Charles E. Burgess, Burgessville.

St. Thomas, Ont.
Tenders received by engineer, M. Ferguson, until April 26 for construction of cement walks and curbings for the city this year.

South Norwich, Ont.
Tenders received by clerk, Alex. McFarlane, Otterville, until May 7, for construction of Singer drain, including 10,900 feet of tile for Township Council.

Sutton, Sask.
Secretary-treasurer, G. E. Saywell, Mazenod, receiving tenders for $120,000 road work for Rural Municipality of Sutton No. 103.

Toronto, Ont.
Works Commission R. C. Harris has recommended the construction of a sewer on Don Esplanade and Front Streets, estimated cost $15,000. Secretary, T. McQueen.

York Township, Ont.
Tenders close May 5 for trenching, laying, jointing, and testing water mains, etc., for the Township Council. Plans and specifications at office of engineer, F. Barber, 40 Jarvis Street, Toronto.

CONTRACTS AWARDED.

London, Ont.
The Brick Manufacturing Company, 621 William St.; W. Heaman & Son, York St.; W. Copp, 93 York St., and Hayman & Mills, 280 Maitland St., have been awarded contracts by the city for supplying tile sewer pipes. Engineer, H. A. Brazier.

The following contracts have been awarded for the construction of pavements, costing $82,000, for the city: Foundations, W. J. Boss, 853 Maitland St.; asphalt, Imperial Oil Company, 56 Church St., Toronto; cement, Hayman & Mills, 280 Maitland St., and W. Copp, 93 York St. City Engineer H. A. Brazier will supply the dressing.

Mitchell & Mohan, 303 King St., has general contract for sewer extension for City Council. Engineer, H. A. Brazier.

Moncton, N.B.
Warren Bituminous Paving Company of Ontario, Ltd., McKinnon Building, Toronto, have been awarded contract for 40,000 square yards of pavement, costing $110,000, for the city. Architect, J. F. Masters.

St. Lambert, Que.
The contract for concrete pipe for trunk sewer has been awarded to the Ideal Concrete Products Company of this town. In the "Contract Record" of April 4 it was incorrectly stated that the contract had been awarded to the Ideal Construction and General Supply Company, 211 McGill St., Montreal. The town engineer is H. A. Gibeau.

Woodlands, Man.
Simpson & Shepman, Winnipeg, secretary-treasurer, Mayor J. Proctor, and Jones & Jones, Warren, have been awarded contract for road construction for the Township Council.

Railroads, Bridges and Wharves

Antigonish County, N.S.
Tenders received by commissioner, Hon. E. H. Armstrong, for the construction of three wooden bridges for the Provincial Department of Public Works and Mines, Halifax. Plans and specifications at office of Provincial Engineer, Halifax, or Boyd & McGillivray, St. Andrew's; Alex. McPherson, Cloverville, and Duncan Chisholm, Antigonish.

Brockville, Ont.
Grand Trunk Railway, head office, Montreal, Brockville Division, will shortly start work on subway near here.

Canora, Man.
Canadian Northern Railway plan stock yard. Address, Mr. Fraser, C.N.R. Station, Edmonton.

Ceepee, Sask.
The erection of a $3,700 bridge over Saskatchewan River is planned.

Cobourg, Ont.
Plans prepared and tenders will be called soon for erection of cement and iron bridge, costing $3,500, for Town Council. Engineer, George Armour.

Dauphin, Man.
The Canadian Northern Railway plan extension to platform and store building. Cost, $8,500. Address, Mr. Fraser, C.N.R. Station, Edmonton.

Hamilton, Ont.
C. Wetteran has drawn plans for alterations costing $15,000 to building for the Canadian Pacific Railway Company, Windsor Street Station, Montreal.

Manitoba, Province of.
The Canadian Northern Railway plan improvements to water system at Togo, Strevel, and Roblin, at cost of $3,000 in each case. Address, Mr. Fraser, C.N.R. Station, Edmonton.

Pakowki, Alta.
Canadian Pacific Railway Company plan railway station. Manager at Calgary.

Port Mann, B.C.
Canadian Northern Railway plan erection of 15 or 20 cottages for employees. Address, Mr. Fraser, C.N.R. Station, Edmonton.

Red Deer River, Alta.
Provincial Department of Public Works, Parliament Buildings, Edmonton, or C. W. Wilkinson, Jenner, plan erection of bridge.

Saskatchewan, Province of.
The Canadian Northern Railway plans erection of seven $1,200 frame sectionhouses this year. Engineer, Mr. Fraser, C.N.R. Station, Edmonton.

Winnipeg, Man.
Plans and specifications for a $200,000 steel and concrete bridge to be erected by the City Council over the Assiniboine River are with the assistant engineer, W. A. Aldridge. Engineer, W. P. Brereton, 223 James Avenue.

CONTRACTS AWARDED

Harrow, Ont.
James McGill, Harrow, has the cement and the Canadian Bridge Company, purchasing department, Walker Road, Walkerville, has the steel contract for the $8,000 bridge for the Municipal Council.

Tilbury North Township, Ont.
The Stratford Bridge and Iron Company, 91-97 Erie St., Stratford, have the steel contract in connection with the erection of four bridges for the Township Council.

Public Buildings, Churches and Schools

Beauport, Que.
The curate, L. A. Deziel, is receiving tenders until noon, April 28, for interior work costing $76,000 for a church owned by the parish of Beauport. Plans and specifications with the architects, Tanguay & Lebon, 20 D'Aiguillon St., Quebec.

Creekford, Alta.
Public School Board plan erection of a school. Address, D. E. MacLean, R.R. No. 3, Strathcona.

ESTABLISHED 1886

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **May 2, 1917** **No. 18**

Principal Contents

Page
Editorial 387
Construction Details of Big Aqueduct 389
Highway Bridges and Culverts 393
A Canadian Munition Factory 395
Brick Roads and Pavements 396
Width of Wagon Tires for Loads of Varying Magnitude on Earth and Gravel Roads 397
Relation of Sewage Disposal to Water Supply 398
Letter to the Editor 400
Practical Hints for the Contractor 401
The Water Powers of the Nelson River 403
Mainly Constructional 406

A Notable Piece of Work

IN this issue appears the last of a series of six articles dealing with the big aqueduct, now nearing completion, to carry in the water supply of the Greater Winnipeg Water District. These articles have been specially prepared for this journal by the assistant and division engineers of the District's engineering staff. They cover very fully the main features in the construction and building of the aqueduct that have made it, from a contractor's point of view, a decidedly notable achievement. The articles have been written essentially for the contractor, and the elements of design, either structural or hydraulic, have been purposely omitted, so that the more practical considerations might receive fuller recognition. The majority of our readers are interested in the way things are actually done, and for this reason we commend to them this series, which provides an authoritative account of the methods and schemes adopted by progressive contractors on a work in many places difficult and perplexing.

The scheme for supplying water to Winnipeg and the environs is one of the really big projects undertaken within recent years on this continent, for the building of a closed concrete waterway, 85 miles in extent, through a country largely muskeg, flat and poorly drained, is no mean job. Credit, in great measure, is due to the contractors' and the District's staffs for the progress and the high quality of workmanship that obtains under these trying conditions. Further credit is due for the manner in which the entire project has been organized and for the way in which the organization has set about overcoming the difficulties that have crept up as the work proceeded.

* * *

Our articles, concluding with the one in this issue, have outlined the general features of the work, the organization of the contractors, and the methods of excavating and concreting adopted on the various contracts. The progress of the work has been, in general, up to schedule. Where contractors have failed to live up to the program outlined they are taking measures to install extra mechanical equipment to ensure greater speed. Certain circumstances have exerted retarding influences, of course, such as the general shortage of labor and the fact that, according to the contract terms, resident labor must be employed whenever possible. The characteristics of the eastern portion of the territory, through muskeg and poorly-drained flat areas, also retarded progress; the speed and energy exhibited by the contractor on contract 30 is, perhaps, in part attributable to the open prairie country, which enables a smaller force to accomplish as much as a larger force in the more difficult peat and muskeg regions.

The contractor's organizations, as described in the second article, March 7 issue, have been arranged to get the best results and the maximum progress by proper co-ordination of administrative, construction, and camp units. The arrangements for men, so far as boarding and camping are concerned, are as nearly as possible ideal. The telephone is the chief factor in providing the proper co-operation of field offices and headquarters, so that daily reports can be the rule. In addition to the organization and arrangements evolved by the contractors, the District authorities themselves have undertaken a great deal that concerns the project as a whole. The most notable has been the construction and operation of a complete standard railway line to provide transportation. Another distinctive feature of the work was the supplying of graded aggregate to the contractors by the District forces. The details of the scheme and the advantages derived therefrom are described in the first article, appearing in our issue of February 28, and in an editorial comment of March 7.

* * *

The notable feature of the excavating work, as outlined in the third and fourth articles, is the universal use of machinery with hand labor employed for trimming of the trench only. The different conditions at the various camps have naturally varied the types of machines and the methods of doing the work. All forms of excavating machines are, however, in evidence. One contractor makes very wide use of "walking dredges," which have been found very effective and accurate; also useful, as well, for backfilling. Steam shovels have been used in other camps almost exclusively, while drag lines have been the principal excavating machinery in still others. The types of machines and their applications have been varied, according to the nature and depth of cut and local conditions. Drainage and quicksand problems have introduced special difficulties in some places, calling for varied solutions.

The concreting operations have demanded methods and equipment as diverse as those for excavating, and the contractors show a high degree of initiative and resourcefulness in evolving the most suitable ideas. The fifth and sixth articles, in the last and the present issues respectively, describe these operations. The general principles of constructing the arches and inverts are the same, but the methods of performing these operations are suited to individual requirements and conditions. The reader is referred to the text and illustrations for details.

* * *

As is only to be expected, the methods intended to be used have, upon application, proven, in many instances, inadequate or unsuitable. Further, unforeseen circumstances and inevitable conditions have made revision of processes necessary, or have caused the introduction of new kinks. Many of these are amply described. To show how a revision of plan may save money and labor, we repeat a very simple instance given in this week's article. At the beginning of the job the the narrow gauge tracks from the main line past the mixer were laid on trestles four to six feet above the ground level, which necessitated the placing of the mixer very high up. Later it was found that the gasoline locomotives could climb a 1:20 grade with full load, so that the trestle was replaced by a graded approach, rising to the elevation of the main line at the junction point. A saving in the use of skilled labor was thereby effected, as well as a saving in time due to loading the mixer at ground level. These articles, covering the construction details of the aqueduct, although applying to work on a large scale, contain ideas of worth to any contractor. They are eminently practical, and their authorship is a stamp of authority. Moreover, they do not praise unduly the good work and gloss over the bad. In more than one instance the author has noted errors of judgment on the part of one or another contractor, and pointed out where a revision of plan would mean profit to all. This impartial attitude of the authors makes the articles all the more In a work of this magnitude it would be that no weak points developed. The were so few, and that these were ptly and effectively.

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York Township, Ont.

Tenders close May 5 for trenching, laying, jointing, and testing water mains, etc., for the Township Council. Plans and specifications at office of engineer, F. Barber, 40 Jarvis Street, Toronto.

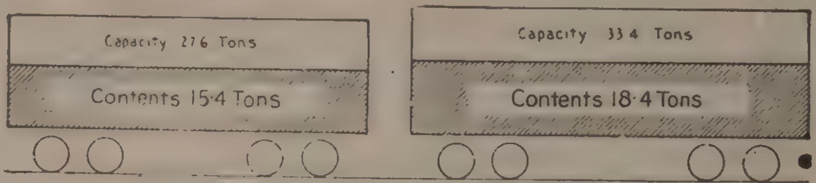
CONTRACTS AWARDED.

London, Ont.

The Brick Manufacturing Company,

Consignees Can Help in Overcoming Freight Congestion

THE freight congestion which has existed in Canada for some time has caused inconvenience throughout the country generally, and in many cases serious losses. The C.P.R. Company, in view of these conditions, are appealing for the co-operation of their customers, in an endeavor to introduce a greater element of thrift into the transportation problem. They point out that much more tonnage could be handled with the existing locomotive power and terminal facilities if cars were loaded to capacity instead of being so often only two-thirds or half full. Many consignees order less than the full carload of freight, often merely the minimum allowed under the classification. It would materially help to solve the problem of congestion if, in placing orders, consignees would order enough to fill a car to capacity instead of the minimum, which very often does not represent more than half a carload. Canadian business men are, therefore, being urged to co-operate with the railways in their endeavor to increase the existing carrying capacity, by using to better advantage the present available rolling stock. Light bulky commodities, of which there are many, should be loaded to the full cubic capacity of cars. Heavier freight should be loaded to the full carrying capacity, which is 10 per cent. in excess of their stencilled capacity.



The capacity and average load per car in the years 1907 and 1915 respectively.
The failure to carry capacity loads causes a dearth of cars.

The following figures are taken from the railway statistics of the Dominion of Canada, issued by the Deputy Minister of the Department of Railways and Canals, and cover all the railways of Canada:

	1907.	1915.	Increase. Per cent.
Total tons freight carried one mile	11,687,711,830	17,661,309,723	51.1
Aggregate capacity of freight cars (in tons)	2,908,903	6,731,265	131.4
Total freight cars.......	105,540	201,690	91.1

The drawing herewith indicates the capacity and the average load in the years 1907 and 1915.

It will be noted that, while the average car capacity was increased 5.8 tons, the average load was only increased three tons, 48 per cent. of the additional capacity provided not being used. The C.P.R. point out that, by increasing the average car load to 23.4 tons, or five tons more than during 1915, the result would be equivalent to the placing of 54,800 additional cars in service.

Mount Royal Tunnel Opened

The Canadian Society of Civil Engineers, the Montreal Builders' Exchange, the Harbor Commissioners, the engineering department of McGill University, and various railways were represented at the unofficial opening of the Mount Royal Tunnel of the C.N.R. on April 21. A large number of passengers made the trip through the tunnel.

Constructional Details of Big Aqueduct

The Last of a Series of Articles on the Contracting Features of the Winnipeg Waterway—The Equipment and Methods for Concreting on Contracts 32, 33 and 34—Travelling Chutes and Form Carriers Used.

By W. R. Davis*

THIS is the sixth of a series of six articles describing the construction of the 85-mile aqueduct section of the Greater Winnipeg water supply conduit. The previous articles describe the general features of the project, the contractors' organization, and the methods of excavation and of backfilling. In our last issue the article by John Armstrong dealt with the contractors' methods of concreting on contracts Nos. 30 and 31, where the equipment and methods used have hitherto been different from those used on contracts 32, 33, and 34, which are outlined herein.

The aqueduct trench was roughly excavated on the contracts under discussion by means of drag-line machines, and to a depth not closer to grade than six inches. The remaining material was afterwards removed by hand immediately prior to the pouring of concrete. On contract 32 the trench varied in depth from four to eight feet, and on contract 33 from two to twelve feet; on contract 34 it was in some places as deep as 23 feet.

Layout of Plant for Concreting

Fig. 1 shows the general layout of one of the mixing plants, which consists of one three-quarter cubic yard London side-loading mixer, equipped with a pair of steel runners, extending from the side of the machine down to the ground level, to permit of the power-loading skip, which on the standard type mixer is fastened rigidly to the side of the machine, to be elevated to any height at which the plant may have to work.

The sand and gravel storage platforms are built of 3 in. x 12 in. x 20 ft. lumber, laid lengthwise on cross-timbers, cut along the right of way in the immediate vicinity. These platforms are from 300 to 500 feet long and 12 feet wide, and set from two to three feet below the level of the District's railway track, to ensure free dumping of the material.

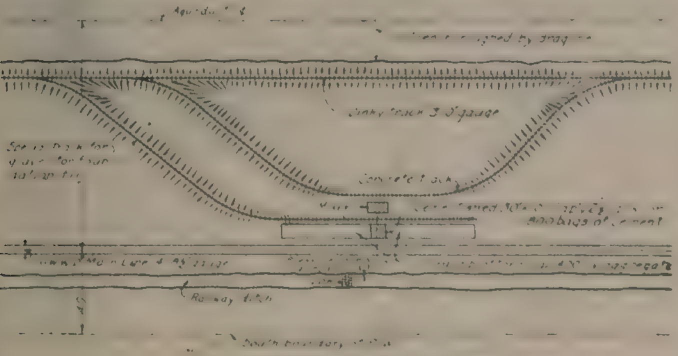


Fig. 1—Typical concreting plant layout.

The cement sheds are 30 ft. x 10 ft. in size, and have sliding windows on the track side and a large sliding door at the mixer end. These sheds are built in sections to facilitate their transportation from one location to another.

Construction track of 20-pound steel and 36-inch gauge is laid alongside the sand and gravel platform, and steel hopper dump cars of one cubic yard capacity are used to convey the aggregate from any part of the platform to the mixer loading skip.

Water from Ditches Supplied to Mixer

Water from the railway ditches and borrow pits in the immediate vicinity, which are dammed up during the dry season, is supplied to the mixer, under pressure, by means of an Atlas Deming pump and type K.B.B. 2 h.p. Middleton engine, attached to a 500-gallon pressure tank.

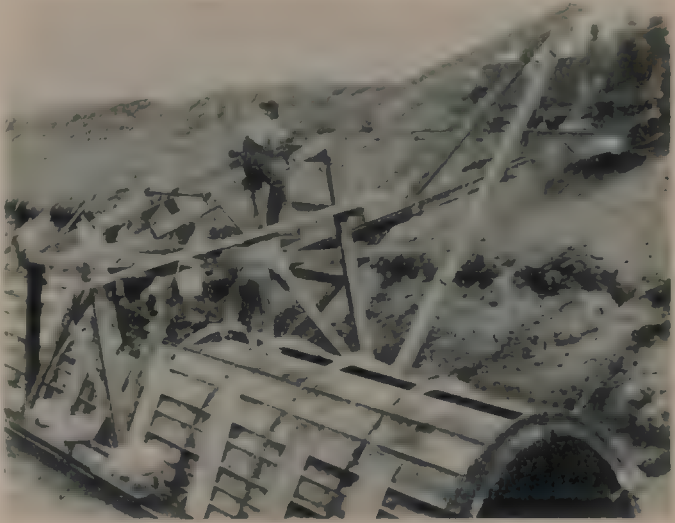


Fig. 2—Pouring a 45 ft. pioneer arch by means of steel chute suspended from a travelling carrier.

This portion of the plant is generally set up on the south railway berm, opposite the mixer, and the delivery pipe is laid through the ballast under the railway track.

At the beginning of the job the siding track branching out from the main line and running past the mixer was laid on a trestle about four or six feet above ground level. This arrangement made it necessary to set the mixer very high up.

Later it was found that the gasoline locomotive used for transporting the concrete had no difficulty in climbing a grade of about 1:20 with its customary load, and the trestle work was supplanted by a graded approach, commencing at about ground level at the mixer and rising to the elevation of the main line at the junction with it.

Grading Instead of Trestle Saves Time and Labor

This grading can be done with ordinary labor, while the building of the trestle work required more or less skilled labor. The change also meant a considerable saving of time in charging the mixer, to say nothing of the saving of cribbing for that machine.

The main transporting track is laid on an embankment paralleling the aqueduct trench, made from the spoil excavated from the trench. The height of this embankment above ground level depends upon the depth of the trench in which the aqueduct is built, and, so far as possible, is so arranged that the chutes to the forms have the proper slope to permit the concrete to flow freely into the forms.

---

* Division Engineer.

With each set-up of the mixing plant 1,800 feet of aqueduct (each side of the mixer) can be completed economically. Beyond this distance the haul is too long to keep the mixer working up to its capacity.

Numerous styles of chutes have been tried out on this job. The contractor's superintendent, Mr. William Smaill, designed and built the one shown in use in Fig. 2. This type has proven itself the one best adapted for pouring the arch concrete. The carrier for this chute runs on 20-pound steel rails, spiked to 3 in. x 10 in. planks laid alongside the invert concrete, and which track also carries the outside arch form travellers. The steel chute, being collapsible, can easily be extended to any length required, raised or lowered. A short chain and hook, fastened to the bottom of the hopper portion of the chute, serves to anchor the chute to the dinky track.

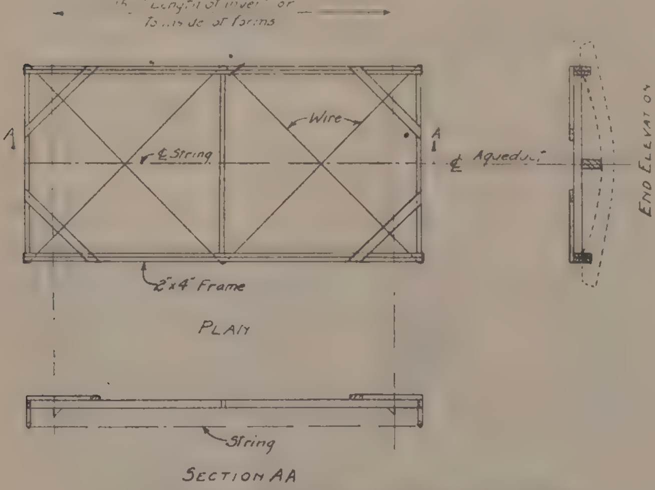


Fig. 3—Frame used for truing and setting invert profiles.

A somewhat less complicated chute carrier is used when pouring invert concrete. This consists of a frame travelling on two wheels running tandem in the bottom of the trench on the side nearest the construction track. The chute portion is identical in design to the one used for arch pouring, but is extended so as to prevent a big drop of the concrete free in air.

Two Cars Keep Mixer in Continuous Operation

In order to keep the mixer in continuous operation two cars are used, one on either side of the mixer, for transporting the aggregate to the mixer; while one of these cars is being dumped into the mixer loading skip the other is being loaded. Excepting during the very hot weather, or when the mixer is run more than ten hours continuously, two gangs of three men each, loading aggregate, one man handling the cement and one mixer engineer, with an assistant to add the water to the mix and to dump the concrete into the transporting cars, can keep the mixer running without interruption.

The mixing is done under the supervision of an assistant inspector, in the employ of the District. To ensure the uniform loading of the batches, the aggregate cars are marked on the inside with paint or a line of punch marks, to indicate the level to which they are to be filled. The capacity of these cars being considerably in excess of the sizes of batches mixed (16 to 18 cubic feet) the centre of gravity is rather low down in the cars, and in order to facilitate dumping it was found advisable to equip them with false bottoms.

Machines were tried for counting and tying up the empty cement sacks, but did not prove satisfactory for several reasons, chief of these being the fact that the tie wires would break under the ties. This work is now being done by the man who empties the cement into the loading skip and after the day's pouring is finished.

Gasoline Dinkies Haul Concrete

Three-ton, 23 h.p., gasoline locomotives, equipped with friction drive for variable speed transmission, haul the carloads of mixed concrete from the mixer to the forms, the cars being similar to those used for conveying aggregate to the mixer, as previously described. Three cars are used for short hauls and four cars for the longer hauls. These dinkies have given excellent service.

The design of the aqueduct calls for construction of the structure in two operations—first, the invert or floor, and, second, the arch. The former is poured in alternate sections, 15 feet long. Steel or wooden end forms, or so-called profiles, are used for this purpose. They are made in two halves (upper and lower), to admit of an expansion joint and the placing thereon of a waterstop of 20-gauge copper, six inches wide, and equal in length to the width of the invert. When bolted together these profiles are shaped to the contour of the invert and are connected in pairs with channel irons at their ends. These are set to grade and centre stakes given by the engineer field party by means of a wooden frame, explained in Fig. 3. Immediately after these forms are filled the concrete is screeded with an angle iron 17 feet long and having a handle at each end. The screeding iron is started from the middle of the invert and worked first upward to the right and then to the left outer edge of the pad by a slow see-sawing motion, care being taken that the concrete does not pile up in front of the screed so that it will flow over it or cause the iron to rise or sag because the pad is not full enough. Men experienced in this work will make a good job of the screeding by going twice over the surface. Sometimes a light screed of wood is used for the second treatment.

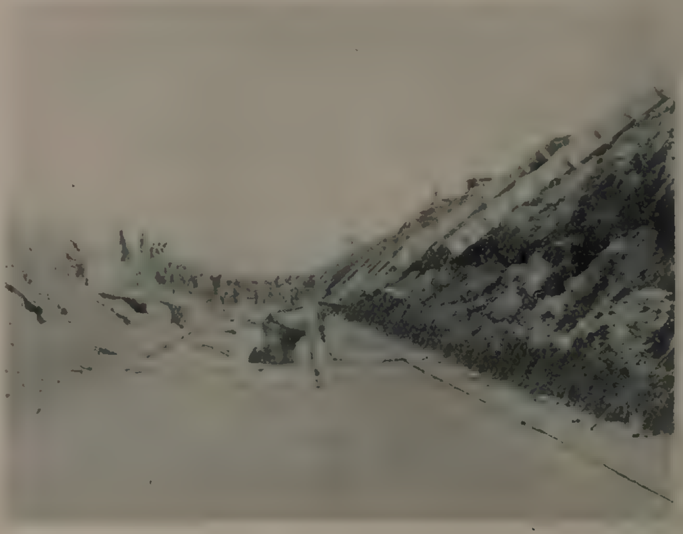


Fig. 4—Finishing a 15 ft. closure invert pad.

Reinforcement Worked Into the Concrete

If the invert requires to be reinforced (as is the case on some sections) the reinforcement, consisting of square twisted bars, can best be worked into the concrete immediately after the form is filled, as the proper location for these bars is only 1½ in. below the surface. This method will also help to compact the mixture, which in this portion of the structure is poured with concrete of somewhat drier consistency than the arch concrete, so as to permit accurate shaping of the pad surface without unduly prolonging the screeding process.

The concrete-placing gang consists of six men, under a sub-foreman. Four of these spread, ram, and spade the concrete, while two men, stationed on the embankment, tip the cars, keep the hoppers clean, and assist in shifting the chutes, the hopper end of which is carried, when being shifted, on a small flat car kept handy for this purpose.

The screeders are followed by a cement finisher, who floats and trowels the invert to a smooth finish (Fig. 4). He then sets a 15-foot strip of soft wood, ⅞ in. x 1¼ in., about midway in the shoulder of the invert, which constitutes the joist between invert and arch. This wood strip is intended to make the joint water-tight, and is set half in the invert and half in the arch.

Tarpaulins Protect Fresh Concrete

Freshly-poured inverts are protected against "baking" in the hot weather and against the effects of rain by means of canvas stretched on "A"-shaped frames made of light poles. These covers are made about 17 or 18 feet long, and extend well over the sides and ends of the forms, and are just high enough to allow the finisher to work under them when necessary. In cool weather lanterns may be suspended from the ridge pole to hasten the setting of the concrete.

When these pioneer inverts have become set sufficiently, the end forms, or profiles, are removed and invert shoulders are brushed with a stiff wire brush to remove all laitance and to expose a clean, even surface. The intermediate spaces for closure pads are then excavated to grade and filled with concrete. It is essential that the finished invert be continuous for a considerable distance ahead of the pouring of arch concrete.

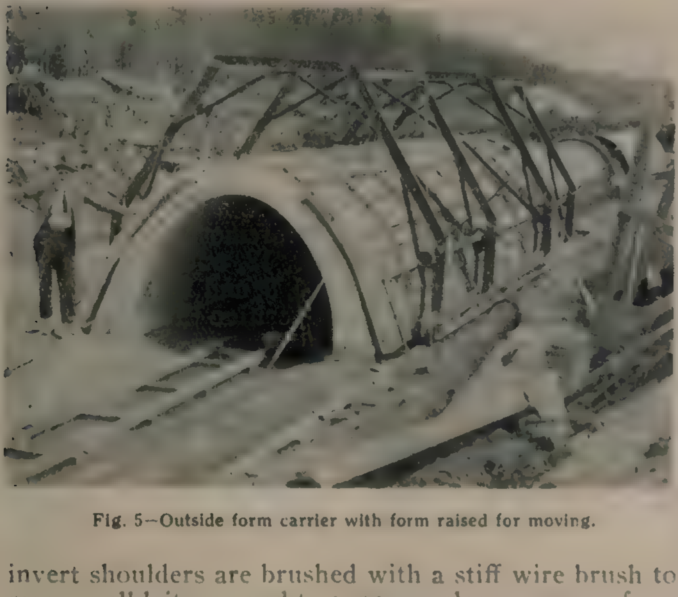


Fig. 5—Outside form carrier with form raised for moving.

The arch forms, as well as the steel profile forms, are supplied by the Blaw Steel Construction Company, of Pittsburg. They are made in 5-foot sections, which are bolted together. The standard length of arch poured at one operation is 45 feet.

Inside Arch Form Rigs

The inside arch forms are supported on an "A" frame steel traveller, running on narrow gauge track laid in the centre of the invert and equipped with "steamboat" ratchets and radial turn-buckles attached to gusset plates, for raising, lowering, and adjusting the forms to their proper line and elevation. These carriers, conveying the forms for the small sections, are usually pushed ahead by hand, while those conveying the ones for the large sections are equipped with a windlass set inside of the "A" frame, which winds a drawing cable anchored ahead. A wooden shoe attached to the bottom plate of the arch form prevents its lower edge from damaging the invert concrete. Wooden spacers are used between the shoe and the ties of the traveller track. These prevent the form when set from bulging inward, while tie rods, equipped with turn-buckles and attached to the bottom gusset plates, prevent the form from bulging outward. Tapered bolts are used to tie the outer to the inner forms.

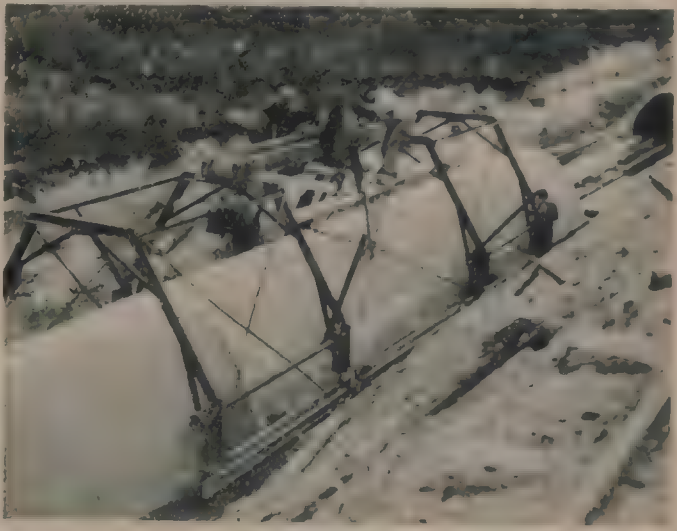


Fig. 6—Outside form carrier being moved by means of a windlass.

It has been found advisable to set the inside forms for the pioneer arches about a quarter of an inch higher than the required height of the finished arch to allow for the slight settlement or adjustment of the form, which seems to occur while the concrete is being poured. Some difficulty was experienced in setting the inside closure forms between some of the first pioneer arches poured, on which no allowance had been made for this settlement. After being set to grade and lined up, both inside and outside forms are well oiled with form oil. In consequence of this they come out clean and yield a finished arch with a smooth, shining surface.

The setting, as well as the removal, of the forms and the work incidental thereto is being done by two gangs of six to eight men, each in charge of a sub-foreman. One of these gangs handles the inside form while the other looks after the outside form.

Travellers Carry Outside Arch Forms

The outside forms are moved by means of a traveller, built of channel and angle iron, which straddles the arch and is run on the same rails which carry the chute trestles. The main features of this traveller are the revolving shafts, of which there are four. They are operated by ratchets with long levers at the inside end and a capstan head at the outside end (Fig. 5). Just inside of the framework, and near the ends of these shafts, short pieces of cable are fastened to an eye-bolt through the shaft. Clevices attached to the other ends of the cables are run through bolt holes in the angle iron on the outside forms. The whole 45-foot section is then raised to the desired height by winding the cable around the shaft. Instead of the cables and clevices, chains and hooks were originally used, but it was found that hooks of a suitable design could not be made strong enough to prevent their bending out of shape under the load of the forms. The cable is better adapted for the winding process than the chains, for obvious reasons, and on a job like this many short pieces of cable are available for this work which would otherwise be practically useless.

Various means of propelling these travellers have been tried out at different camps. Fig. 6 shows one of them equipped with a windlass for this purpose. In this case the cable is anchored to a deadman laid behind and fastened to bars set into the concrete invert shoulder at convenient intervals.

Moving the Forms

Another method used at other camps, and which is perhaps the most satisfactory, is to attach a cable to the top front channel beam at its centre and to run it through a block anchored to the dinky track some distance ahead. The loose end of the cable is then attached to the gasoline locomotive, which draws in the direction opposite to that in which the form is to be moved. The only objection to this latter method is the fact that the travellers carrying the forms for the small sections jump the track occasionally on account of the side pull, but where the large forms are used this system works out very satisfactorily.

Heavy steel bulkheads are bolted to both outside and inside forms after these have been set in place, and thus lend rigidity to these forms. Like the invert forms previously described, these bulkheads are made in two parts to permit the insertion of a copper water stop in the expansion joint.

The gang which places the invert concrete also looks after the pouring of the arches. The second, fifth, and seventh plates in the second row of plates from the bottom upwards, as well as the top plates in all of the outside forms, are left out to facilitate the spading of the concrete until it rises to the level of these openings. All the concrete is poured over the top of the inside form. By thoroughly spading the concrete against both inside and outside forms and by an occasional tapping of the inside of the inner form with a wooden mallet practically all pittings apt to result from inclusion of air bubbles in the concrete are avoided. Four complete sets of outer and six complete sets of inner forms are used at each working point.

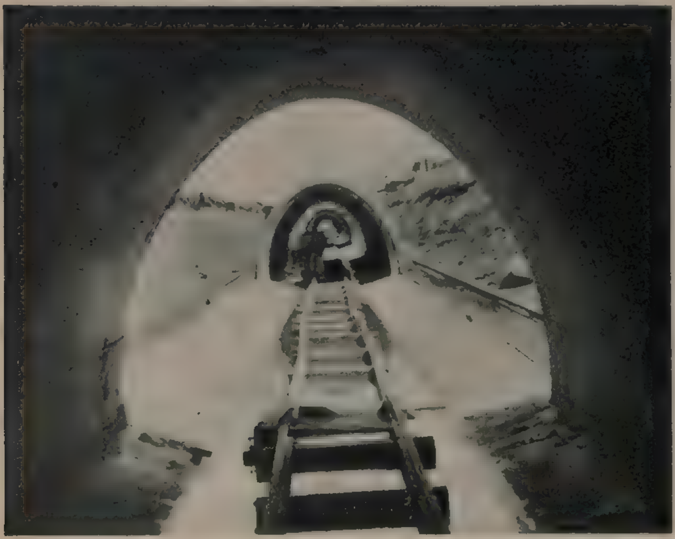


Fig. 7—Finisher cleaning spills from inverts before pouring arch.

Getting Full Use of Forms

Because the inner arch forms cannot be passed through others in position the arrangements for getting the full use of these forms and in order to prevent one fouling another are interesting. It is imperative that the setting of the forms be done systematically. Several arrangements have been suggested and tried out. The procedure described below seems to have given the best results. Pioneer arches are built in alternate spaces from 1 to 11, both inclusive. So soon as they can be released the three foremost forms are run ahead, the first to space No. 17, the second to No. 15, and the third to No. 13.

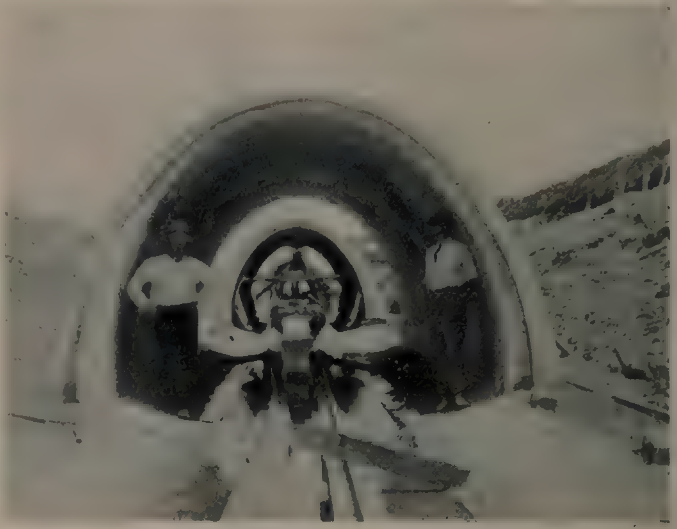


Fig. 8—The largest arch section. The illustration on the left shows the smallest section.

The form foremost in position is always poured first. When they have served their purpose these three forms are each moved six spaces ahead of their last position. This leaves the even-numbered spaces for the rearmost three forms which are used for building the closure arches. The foremost form of these latter three will fill spaces 10, 12, and 18, while the second and third take care of 6, 8, and 16—2, 4, and 14 respectively. From their last position these three rearmost forms are also taken six spaces ahead at each move, thus making the operation continuous. Two outside forms serve with each set of three inside forms.

Bends in the line of the aqueduct are built in 45-foot chords, and the necessary fillers are put in with wooden forms.

Finishing Operations

A cement finisher is detailed to clean the inverts of spoils, if any, and to fill the holes left by the tie bolts. As soon as a set of forms has been drawn a wooden plug is driven into each of these holes from the outside; a fairly dry cement mortar is then rammed into the holes.

"Green" arches are protected by sprinkling against drying out. Where the aqueduct passes through swampy lands it has been found expedient to cover the top and, so far as is practicable, the sides of the arch with sod or decayed vegetable matter taken from the spoil banks. This covering, when thoroughly wetted, will retain moisture for a long time. During cool weather the setting of the concrete is hastened by the use of small coke salamanders within the structure.

The comparatively small volume of concrete per linear foot of aqueduct, ranging from 0.508 cubic yards in the smallest section, shown in Fig. 7, to 1.110 cubic yards in the largest section, shown in Fig. 8, was the governing factor in the laying out of the concreting plant and in the selecting of the type of forms to be used. Payment is made for the concrete in the aqueduct on the basis of definite dimension lines set out in the plans, and the contractors are obliged to absorb all loss and waste of materials used in additional concrete placed outside of the prescribed neat lines of the structure. It is therefore essential for the excavation for the invert or floor of the aqueduct to be carefully trimmed and the arch forms to be securely bolted and spaced to the required dimensions, which are checked by the resident chief inspector on the job, who is in the employ of the District.

Supply and Handling of Material

The District supplies the contractors with cement and aggregate, the former being delivered in carload lots by the way-freight train on alternate days. These cars are spotted alongside of the cement shed and unloaded after the day's concreting is finished, so that the working gangs are not disorganized, and the empty cars may be picked up by the way-freight upon its return the following day, or they may be picked up by a passing gravel train and collected at the nearest siding. The sand and gravel, ready mixed in the proportions required for the work in hand, are delivered daily, as requisitioned, in 20-yard air dump cars. The cement is charged to the contractors at cost price and credited at the same figure when used in the work as ordered. The sand and gravel is sold to them outright at a price stipulated in the contract.

Highway Bridges and Culverts

Important Considerations in Their Construction—Shop Inspection and Painting—Bridges Suited to the Highways

By W. G. Yorston*

THIS paper deals with general considerations governing steel and concrete bridges and culverts, with special reference to Nova Scotia's experience with various types. The essential requirements of these structures and the important points in their design and construction are dwelt upon. Some salient features are outlined herewith:—

Shop Inspection of Steel Bridges

Thorough inspection of steel bridges in both mill and shop during fabrication will give good results and better value, and the inspection should also embrace the painting of the material in the shop before it is shipped for erection. Inspection companies now make a specialty of this work and the charges made are very small and do not constitute any very considerable item. Bridge companies are only human after all, and their business primarily is to make money out of the construction of this work. Shop foremen are particularly anxious to make records for their different departments and in doing this are apt to neglect important features of the specifications if left entirely to their own devices. The members of the trusses should be completely assembled in the shops before they are shipped, in order to avoid alterations in the field. The shop painting is a very important item, and the material should be thoroughly cleaned before this is done. The neglect of this precaution will involve considerable extra expense in the field painting, after erection.

The inspection should be continued through the whole time of erection, in order to see that the members are properly fitted together and rivets properly driven. Bridge companies should also be required to paint all rivet heads and parts where the paint has worn off, as erection proceeds. After the completion of the erection, field painting should proceed and all the different parts of the structure should be gone over carefully and given two coats of approved paint. The kind of paint to be used varies to quite a degree, although red lead and linseed oil are used in the great majority of specifications. There are other materials, however, which give good results, although the material composing the paint should always be carefully scrutinized and inspected.

Should be Kept Painted

After a steel structure has been erected and properly field painted, it should remain in good condition for a period of from four to five years, depending largely on the condition of the surface of the steel, the quality of the paint, and the care taken in its application. The situation of the bridge has also very much to do with the lasting qualities of the paint covering. At the end of the period spoken of, it will probably be found that rust has begun to make its appearance in patches where the paint covering has disappeared. It is extremely necessary to arrange for a systematic method of maintenance, as regards painting, and this most important matter should be attended to promptly in order to keep the structure in good condition. In some instances it may not be necessary to paint the whole structure at intervals of four or five years, as parts of the structure which are exposed to air and sunlight do not deteriorate as quickly as the covered portions, which are usually beneath the floor and harder of access.

To Secure Uniformity of Tendering

The best practice in purchasing bridges would undoubtedly be to first determine just what type and form the new structure will be, and then to prepare the necessary stress sheets and drawings, so that all who intend tendering for the structure will do so on the same basis. For this work it is best to secure the services of a competent bridge engineer. The cost of the plans prepared in this way is a little more than if they were prepared in the department office by members of the regular staff, and in addition the benefit is obtained of greater experience and the consequent assurance of safety.

Important Items in Concrete Bridges

In building concrete structures, particular care should be taken with the foundations, as the least settlement in any part results in a disfiguring crack and possibly a total failure of the structure. Where suitable foundations do not exist, resort must be had to piling, timber, platforms, etc., in order that the settlement may be avoided.

When mixing concrete, attention is always paid to the quality of the cement, and this, of course, is an important item. The quality of the ingredients mixed with the cement is, however, of quite as much importance, and it is a regretable fact that this important item is often overlooked, and only too often the employment of unsuitable ingredients, either sand or stone, does not give the resulting concrete that could be got had better materials been employed.

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* Assistant Road Commissioner, Nova Scotia, before Canadian and International Goods Roads Congress (Abstract).

Records of Bridge Costs

Records of larger bridges for the office are most important, as it is always essential that it should be known just what the cost for construction and maintenance of the different structures has been. This is especially important in the case of bridge painting, as it is only by such means that any accurate idea can be had, both as to the cost of the work and the anticipated requirements in any season. A good system is to keep a card record. On the face of the card is given all important information regarding the construction of the bridge, its dimensions, cost, etc., in fact all essential information can be given in concise form in this manner. On the reverse side of the card provision is made for records of the cost of repairs and painting. The painting record should show the kind of paint used, the time of year in which the bridge was painted, and its cost. From such records as these, it is possible to tell at any time, the state of repair of all structures on the different highways. As it is too cumbersome and perhaps unnecessary to file individual records for the smaller structures, these can be grouped together in sections in any way desired.

Bridges Suited to the Highways

Bridge structures must be treated as an integral part of the roadway, and to meet the demands of traffic, especially of safety, all parts of the roadway must be wide enough to carry the traffic without danger. To this end all the structures must be made of such dimensions as will allow the maximum width of roadway demanded. All parts of the highway should be kept in good condition, and it is of little use to have well surfaced and smooth roads, if the bridges are not strong, or are unsafe; nor is it good business to have all the bridge structures of the most substantial and ornamental character, if quagmires exist at either end of these structures.

On the contrary, the whole scheme must be balanced, in order to get the best results. Quite true, the element of safety in highway structures must never be lost sight of, but it is quite possible, also, in the fervor of erecting permanent bridges and culverts, to erect these at too great a cost, leaving not enough money to finish up all parts of the highway to the same standard.

All engineers take the utmost pride in building their structures permanently, but at the same time there is a feeling that the garment should be cut to the cloth, and the expenditure should be made to suit the circumstances, and where it is demonstrable on any road of little traffic, that structures of wood can be kept up for a fraction of the interest and maintenance costs of permanent bridges, then the cheaper structure should be built, and the money so saved should go to the main arteries which in most instances, owing to the greater traffic conditions, are generally in need of more money than is available for their construction and upkeep. No general lines for these expenditures can be laid down, but each must be considered on its own merits, as a business proposition, and dealt with accordingly.

Saskatchewan's Joint Committee of Technical Organizations at Work

A BANQUET was held on April 5 at the Assiniboia Club, Regina, Sask., of members of the technical and engineering associations of the province who have associated themselves as a joint committee of technical societies to co-operate for more extensive work in aiding the government in the prosecution of the war. The committee passed a number of resolutions, including one recommending the formation of industrial research laboratories in the Province of Saskatchewan. It was also decided to send out census cards to all technical men in the province, so that the engineering ability and experience available for war work may be properly and readily classified. A sub-committee is being formed to report on inventions of military value. The opinions and suggestions of technical men in the province will be sought on how best to secure an inventory of the natural resources and how to utilize these. Assistance will be given to the advisory council in obtaining replies to certain of their questionnaires. Active assistance in recruiting work will be given the Canadian Engineers. A committee was also formed to consider methods of assisting vocational training of returned soldiers.

The personnel of the Joint Committee of Technical Societies for the Province of Saskatchewan is as follows: L. A. Thornton, chairman, and J. N. de Stein, secretary, representing the Canadian Society of Civil Engineers; F. W. Reilly, W. V. Van Egmond, Saskatchewan Society of Architects; Lieut. R. J. Lecky and H. R. McKenzie, Canadian Engineers, Military District No. 12; R. W. E. Loucks, Saskatchewan Association of Land Surveyors; E. A. Hanson, Saskatoon Engineering Society; Dr. W. W. Andrews, Saskatchewan Chemical Society; J. L. McKay and L. M. Moyer, Regina Builders' Exchange.

Addition to be Built to the Quebec Harbor Elevator

The George A. Fuller Company, Ltd., Montreal, have been awarded the contract for the construction of an addition to the Quebec harbor elevator. It will be about 100 feet high, on a site 256 ft. x 65 ft. The structure, to be used for storage purposes only, is to be built of reinforced concrete on wooden piles, with a tar and gravel roof. The capacity is a million bushels. Structural steel will be used for the conveyor bridges, and a belt conveyor system will be installed, driven by individual motors. The storage bins will total 109. The steel will be supplied by the Eastern Canada Steel and Iron Works, Ltd., Quebec, while the roofing will be carried out by the McFarlane-Douglass Company, Ltd., Montreal, and the electrical work by the Canadian Comstock Company, Montreal. The total cost is $275,000.

The Hill Clutch Company, Cleveland, Ohio, are distributing a bulletin which is the first of a series on Hill clutch equipment. The bulletin describes and illustrates installations of friction clutches, collar oil bearings, rope drives, etc.

The Foundation Company, Ltd., Montreal, have been awarded a contract for the construction of a dam and penstock for Penmans, Ltd., at Coaticook, P.Q., in connection with a small hydro-electric development, to develop 180 h.p.

A CANADIAN MUNITION FACTORY

Munition factory completed in ten weeks.

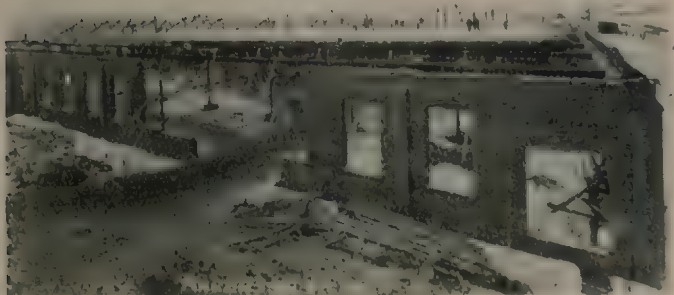
Simple but Substantial Design Intended for Speedy Erection—Completed in 10 Weeks—Part Ready for Machinery in Six Weeks

THE development of war business in Canada has involved the speedy construction of many buildings, the question of cost being a subsidiary one. Time was the essence of the contract, to use a legal phrase, and the energies of the builders have all been directed to getting up the factory in the shortest possible period.

Among Canadian contractors, Anglins, Limited, are known for the rapidity with which they carry out such rush jobs. An instance is a munitions factory in Montreal, illustrated herewith. The building, of one storey, covers an area of 800 x 252 feet, in addition to which there are store, power and transformer houses. The form of construction is of the most simple character, it being essential that the building should be completed in the shortest possible time, coupled with the proviso that the construction should be substantial enough to suit the particular requirements, a large amount of machinery being employed in the making of the munitions.

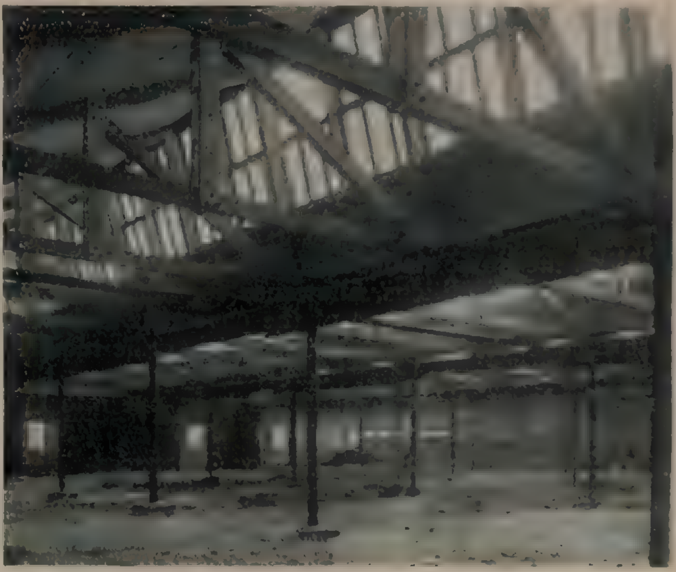
Completed in Ten Weeks

Work was commenced on November 12 of last year and was completed in ten weeks, while the first section was ready for machinery in six weeks. In order to expedite the work, double shifts were necessary. The record thus established is all the more creditable when it is recollected that the entire operations were carried on during the severe part of the winter, and that the deep snow handicapped to a certain extent the work of hauling materials, the construction of the building, and, above all, the immense amount of excavation and back-fill.



Munition factory during erection.

The entire area is covered with 18 inches of cider fill. The walls are of concrete foundation with brick above grade, while the floor is of concrete and cement finish. The roof is of saw-tooth construction, with cast iron columns and steel girders carrying trusses. As showing the urgency with which the building was required, it may be mentioned that the contract for the cast iron columns had to be divided between five firms in order to ensure prompt delivery. The radiators used are the wall section type, suspended on the sides of the steel girders. The building is divided into two sections by fire-walls of brick, and, in turn, these sections are subdivided into various smaller shops by terra cotta partitions. The sills and stone trimmings were manufactured on the site in cement moulds. Owing to the severe weather conditions, a large part of the materials had to be heated, and many carloads of coke were consumed. The windows are of wood, factory type, double hung, and glazed with rib glass. The ventilating sash, or saw-tooth sash, in the roof are operated by mechan-



Interior of munition factory—Cast iron columns and wood roof trusses.

cal means. A large number of lavatories are constructed in various parts of the factory.

The Boiler House

The boiler house, built of brick with a steel stack, for supplying steam for operating purposes and also for heating the building, contains three large tubular boilers and a ventilation and humidifying plant. In addition to this there is a separate transformer house, in which electric current is transformed for lighting and for the individual motors driving various machines.

The extensive character of the job may be gathered from the quantity of materials, in tons, used: Excavation, 14,715; lumber, etc., 1,450; plaster, 230; drains, 102; nails, 100; concrete, etc., 7,300; brickwork, 32,000; steel, 325; millwork, 114; sundries, 1,000. The brick was supplied by the National Brick Company of Laprairie, Ltd., Montreal, and the steel by the Dominion Bridge Company, Ltd., Lachine, P.Q.

Brick Roads and Pavements

High Quality Rather Than Low Cost—Track Allowances Cause Difficulties—Superiorities of New Methods

By D. T. Black*

TO design a brick pavement requires the collection of considerable data, and a thorough knowledge of the district surrounding the highway or street on which the pavement is to be constructed. The type and thickness of foundation, and the width of the pavement, depend largely on local conditions, nature of the subsoil, amount of traffic and the cost of materials. The local conditions denote the formation of the surface as to grades, and should be carefully considered from a complete set of cross-section levels taken the entire length of the proposed work, and close enough to give the correct quantity in cubic yards of excavation and fills. Information as to the productiveness of the district enters under this heading, and should show the industries of the district, whether heavy or light in street haulage, or whether a farming district, or a district for through vehicle or auto traffic, or any specialty of the district. The nature of the subsoil informs as to the bearing power of the soil, underdrain requirements, and cost of excavation and fills.

With the traffic statistics collected, the information on the local conditions, allowance for additional increase during the lifetime of the pavement and with past experience, a fair estimate of the traffic requirements can be formed. It has often been shown that immediately a new pavement has been put into use the traffic has been doubled.

Do Not Sacrifice Quality for Cheapness

The cost of material enters largely into the design of the work. Local material may be very suitable and may considerably reduce the cost of the work; in such a case full advantage should be taken of such an opportunity. On the other hand, the material may require to be brought long distances, and consequently be expensive. In either case, the strength of the work should not be sacrificed in order to utilize a doubtful local material, or to save by the purchase of inferior material.

The construction of a tile drain under the curb is a point worthy of notice. I have heard a contractor say "Why, it is only a field drain, it does not require much care." It is perfectly true; it is only a field tile, but it has been more carefully specified than a field tile would be, and is more important than at first imagined. This curb tile is not below frost line, still its duty is to prevent water getting under the pavement, and to take care of moisture under the base. It should be laid so that each tile will empty, and thus prevent the formation of soft pockets under the curb. It should also be straight and directly under the curb, so that the curb form spikes may not crush it; and lastly, it is expected to remain in perfect condition the full lifetime of the pavement, and possibly longer.

New Constructions Overcome Noise

Brick pavements have, in many cases, been objected to, on account of the noise which follows after the first year in use. To some extent this was overcome by the introduction of the wire-cut-lug blocks, with a considerable improvement in the wearing of the surface. The introduction of the monolithic and semi-monolithic construction promises to still further reduce the objectionable rumbling noise. It is a step nearer the perfect brick pavement if a smooth surface can be obtained with the base and brick surface formed into one perfectly bonded slab, as in these types.

The monolithic construction, generally used on highways and streets not more than 24 feet wide, consists of laying the bricks directly in the green, or newly-laid concrete. The semi-monolithic construction consists of laying the brick on a superfoundation of cement-sand, which is mixed dry and spread on the prepared foundation. The bricks, after being rolled, are well wet down, the cement and sand thus forming a mortar bed, which unites the wearing surface and the foundation.

Paving Track Allowances

The street railway tracks are always a vexing question, and from time to time changes have been made to overcome the failures of the previous methods, largely brought about by the ever increasing weight of cars. Many years ago it was the custom to lay cedar and oak ties at the joints; later the steel tie on a concrete base was adopted, and the rails welded together. In some cities the cedar and oak ties again came into favor, set on concrete, and having the concrete poured flush between to level of top of ties. It seems, however, a considerable waste of concrete to have twelve inches between the ties, and only six or eight inches under the ties where it is most required.

After many experiments steel twin ties have been placed on the market to meet the particular conditions of permanent tracks in paved streets. The twin ties are a fabricated product, made up of two 3-inch channels, 6 ft. 2 ins. long, spaced at 2 ft. 9 ins. back to back, and riveted together with two 5/16 in. x 13 in. x 36 in. steel plates. These plates have their two longitudinal edges warped in 2½ inches to form a tamping pocket beneath them, and also to serve as an anchorage in the concrete. The rail is securely held in place on each plate by four malleable iron clips. This tie seems to be another step in the right direction in track construction, and with sufficient depth of concrete, the track should be rigid and secure. For ordinary city street car traffic 7 or 8 inches of concrete under the rail is considered sufficient, the introduction of the steel plates giving a full bearing. The length of the tie was reduced from the usual 8 feet for a wooden tie to 6 feet 2 inches for the twin tie, and therefore made considerable saving in concrete.

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* Town Engineer, Welland, before Canadian and International Good Road Congress (abstract).

Width of Wagon Tires for Loads of Varying Magnitudes on Earth and Gravel Roads

THE recommendations in this article relating to widths of wagon tires suitable for use on country roads of earth and gravel, as well as upon those of a more improved type, have been prepared by E. B. McCormick, chief of the Division of Rural Engineering, Office of Public Roads and Rural Engineering, United States Department of Agriculture. They are based upon two factors: (1) The unit weight for width of tire commonly used for road rollers; and (2) the results secured from a large series of traction tests extending over several years and made in widely-scattered localities.

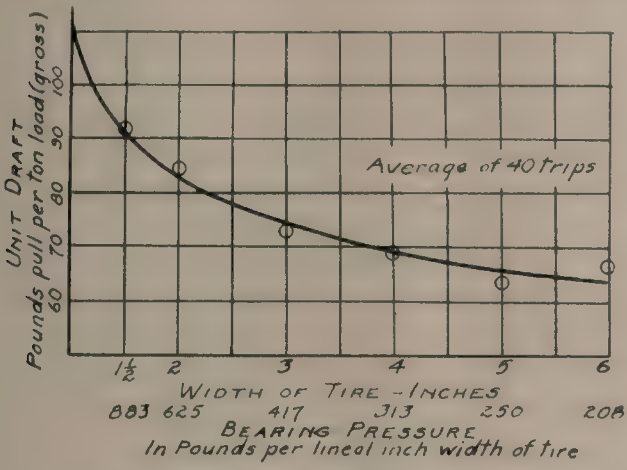


Fig. 1—How unit draft varies with width of tire.

An examination of several of the road rollers in general use shows that they are designed for a weight per inch of width of tire varying from 450 pounds to 650 pounds, more of them ranging from 500 to 550 pounds than within any other 50-pound division. It is apparent that, as this is the maximum weight applied to the foundation and surface of the road during construction, it is not advisable to exceed this weight except in cases of emergency, and then only occasionally.

The curve shown in Fig. 1 is plotted from the results of traction tests recently conducted on a dry earth road which was constructed by the use of a 10-ton road roller having a unit weight on the wheels of 450 pounds per linear inch of width of rim, and with a constant gross load on the wagon of 5,000 pounds. This curve is the average unit draft, by which is meant the pounds pull per ton of gross load for 40 trips; the vertical distance in each case is the measurement of the draft in pounds per ton. The left-hand point on the diagram represents the draft of the 1½-inch tire, the next point that of the 2-inch tire, and so on through the 3-inch, 4-inch, 5-inch, and 6-inch.

An inspection of the curve shows that there is a constantly decreasing unit draft from the 1½-inch through the 5-inch, with an increased draft for the 6-inch tires.

Experiments Performed Under Uniform Conditions

In conducting these experiments the road was constructed prior to the first test by being plowed up, graded, and rolled. After each test, and before the beginning of the next, the road was replowed, graded, and rolled again, so that the condition of the road at the beginning of each test was as nearly the same as it was possible to make an earth road. The trips selected for comparison are those in which moisture and atmospheric conditions were practically the same.

The long series of traction tests mentioned in the first paragraph includes investigation of the influences of many factors other than of tire width, and because of the magnitude of the work many of the results have not yet been calculated, but those that have been calculated conform very closely as to relative draft with those shown on Fig. 1, although the actual draft in pounds varies according to the nature and condition of the road surface.

On Fig. 2 the horizontal distances are the pounds weight per inch of width of tire, as taken from curve on Fig. 1, while the vertical distances are, as before, the unit drafts.

From the curves shown on these figures the following conclusions may be drawn for well-constructed dry earth roads:

With a gross load of 5,000 pounds the unit draft decreases with the width of tire up to and including the 5-inch width.

The unit draft decreases directly as the weight per inch width of tire decreases, until a weight of 250 pounds per inch of tire is reached, as shown by the fact that the curve in Fig. 2 is practically a straight line.

The fact that the draft for a 6-inch tire is larger than that for a 5-inch, in all cases shown, merely indicates that there is no advantage in increasing the width of tire beyond a certain point, and there may be a disadvantage in so doing.

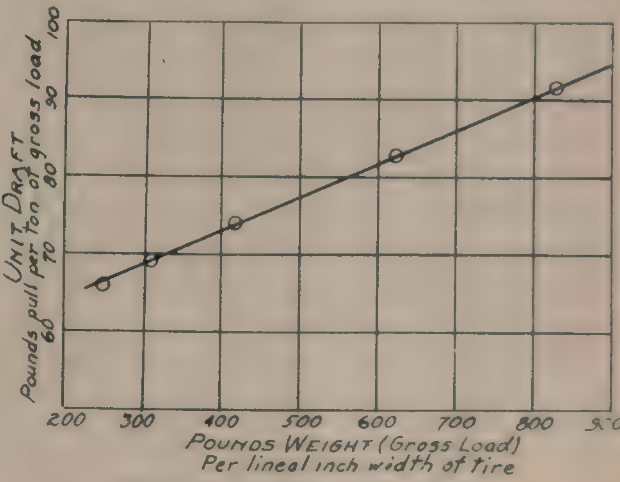


Fig. 2—How draft varies with load on tire.

It is not advisable to exceed in any vehicle a unit weight per inch of width of tire in excess of that possessed by a standard road roller.

Recommendations

Where there has been in the past, and to a certain extent still is to-day, wide variation in sizes and types of wagons marketed by the different manufacturers, it is believed that five sizes of wagons will be sufficient to meet all the needs of farming operations and all general work except the heaviest trucking and certain specialized hauling, which is likely to be confined to city pavements. These five sizes are:

1. One-horse wagon having a gross load capacity of 2,000 pounds and a skein from 2⅛ to 2⅜ inches.

2. Light two-horse wagon with a skein approximately 2½ inches, and a gross carrying capacity of 3,500 pounds.

3. Medium two-horse wagon with a skein not exceeding 3 inches, and designed for a gross load of 4,500 pounds.

4. Standard two-horse wagon with a skein of 3¼ inches and a gross carrying capacity of 6,800 pounds.

5. Heavy two-horse wagon having a skein of 3½ inches and gross load capacity of 7,500 pounds.

As there is considerable difference in the practice of manufacturers regarding the size of skein used on the various types of wagons, it is recommended that wagons be not designated by size of skein, but according to the gross load capacity, and that a name be adopted for each of the sizes. It is further recommended that the gross carrying capacity of the wagon be shown by stencil or plate on the back of the rear axle. The following widths of tire are recommended for each size of wagon, based on road-roller weights and on results of traction tests.

Width of Tire Recommended for Wagons of Different Carrying Capacities

Type of wagon.	Gross weight loaded. Pounds.	Width of tire. Inches.
One-horse wagon	2,000	2
Light two-horse wagon	3,500	2½
Medium two-horse wagon	4,500	3
Standard two-horse wagon	6,800	4
Heavy two-horse wagon	7,500	5

Relation of Sewage Disposal to Water Supply

THE relation of sewage disposal and water supply is undergoing a change. Recent developments in the field of sanitary engineering indicate that a sounder and more rational relationship has been produced, and that the proper principles of coordinating a pure water supply and an effective sewage disposal system are being pursued. The article below, by George W. Fuller, consulting engineer, New York City, in Engineering News-Record, develops this relationship by viewing the progress being made along these lines:

About thirty years ago came the beginning of municipal sewage disposal for American cities. That was the period when the germ theory of disease was coming into general recognition, and the Massachusetts State Board of Health was reorganized, with its experiment station at Lawrence, to co-ordinate the engineering, chemical, and biological aspects of the purification of water and sewage along modern lines.

During the past twenty-five years the successful achievements in the field of water purification constitute one of the brightest pages in the field of sanitary engineering in America. It is true that there is much work still to be done in the field of water purification, both as regards its general adoption and its application at certain places where local conditions call for special treatment. Apparently progress in water filtration has has been somewhat retarded through efforts to make chlorination serve as a substitute for it under conditions where it is not entirely adequate. Chlorination has done a great deal of good in the improvement of public water supplies. But it is not a cure-all, and its limitations are far more clearly appreciated with the practical proofs now existing than when academically recited six or eight years ago.

The Status of Chlorination

In order to effect an adequate removal of objectionable bacteria it is necessary to apply chlorine in quantities sufficient to combine with the dissolved and suspended organic matters before the chemical will act upon the living organisms. The temperature of the water and period of reaction are likewise important. The great difficulty, however, lies in the inability to measure the amount of chlorine which the soluble and suspended (dead) organic matters use up before the chlorine becomes available for destroying the living organisms. Hence for many water supplies, subject to chlorination without filtration, real difficulties are encountered in adjusting the dose of chlorine so as to guard against objectionable taste and odors, on the one hand, and inadequate destruction of objectionable bacteria on the other. Undoubtedly chlorination allows public water supplies of good quality to be furnished without filtration under some special conditions.

Present-day consideration of sewage disposal as related to water supplies involves the assumption that a first-class water supply from surface sources shall be subjected to efficient filtration, preferably aided by chlorination. There may be exceptions to this rule in instances where long periods of sedimentation are provided for water taken from sparsely-inhabited watersheds.

Almost everyone naturally has sympathy with communities which endeavor to preclude sewage pollution from their water supplies. Sanitary engineering in America, however, has been developing a general program of favoring sewage disposal in relation to water supply along those lines which will give the greatest total benefit for a given expenditure of money. Unquestionably sentimental developments bring many problems, at least on paper, outside of the scope of that relationship. And where the citizens can afford it, they will no doubt proceed with that which they desire. Under such circumstances no one should object.

Inefficient Sewage Works Operation

Unfortunately in the past, sewage disposal in treatment works of artificial construction has too often, although needlessly, failed to accomplish that which was expected of it. No matter how adequately sewage works may be designed and built, it is necessary to operate them properly. Inadequate attention to operation is a great weakness in the sewage disposal record of American towns and cities. Statistics compiled by a committee of the American Public Health Association last year showed that of 1,294 American sewage disposal plants, only about 60 were provided with laboratory facilities and presumably with a proper operating staff. However, this record is not as bad as might appear at first glance, as only 93 of the plants serve communities of over 10,000 people.

Perhaps the most striking change in the viewpoint of engineers as to the relation between sewage disposal and water supply is the need of looking at these problems objectively and not subjectively—that is, not in the light of what they might accomplish, but of the work which they really do. In many sections of the country it is unquestionably true that waterways must carry a greater or less portion of the sewage wastes. Prof. Earle B. Phelps has recenly stated in the United States public health reports a general principle for co-ordinating conflicting viewpoints, as follows:

"Conservation of natural resources demands that the greatest possible advantageous utilization be made of the various properties of a stream. This may include such uses as navigation, drainage, and irrigation, power development, domestic water supply, fishing as an industry, pleasurable and health-giving enjoyment by the people in such forms as boating, bathing, and fishing, the disposal of sewage and waste, the enjoyment of scenic beauty, and various minor uses. These may all be indulged without further restriction than that the less important shall not interfere with or curtail the more important, the importance of any usage being measured in broad economic terms of public welfare."

Consideration of Local Factors

It is no longer prudent to say offhand that an Imhoff tank, a fine screen, a trickling filter, or chlorination, is just what is needed for any particular local problem of sewage disposal. To a degree far greater than is generally or clearly realized it is necessary to recognize that local problems of sewage disposal must be solved, if solved wisely, by adjustment to wide range of local factors and conditions. The problems differ so widely that the idea of a general solution applicable to a great many problems is no longer satisfactory.

The 1909 treaty between Great Britain and the United States with respect to controlling the pollution of boundary waters so that life and property on one side shall not injure health or property on the other has done much toward crystallizing the viewpoint herein discussed. Essentially work on boundary waters has been directed toward a co-ordination between natural conditions and agencies and needed works of artificial construction, all with a view of bringing about a combined effect intended to give proper hygienic results with due regard to the financial aspects of the case.

International Commission's Allowable Pollution

In 1914 the International Joint Commission, on the basis of expert testimony, endeavored to establish a limit in the pollution of boundary waters, the intention being to designate a proper load for water filters beyond which limit pollution should not be allowed to go. This testimony indicated an allowable degree of pollution corresponding upon an average to that found in the Thames River at Hampton, England, or to the condition of the Merrimac River water at Lawrence after the latter had been freed of about 90 per cent. of its pollution. An effort was made to study this question bacteriologically in terms of determinative B. coli, but the available presumptive B. coli data in this country are so intimately associated with uncertain methods of analysis indicating the presence jointly of fecal and non-fecal members of this group, that this phase of the subject is now much muddled, and it will be necessary to get further data on a more reliable basis.

Professor Phelps has endeavored to express the bacteriological limits in the pollution of water which may be safely applied to water filters in terms of stream flow per capita, with due account given to "self-purification." This is, of course, desirable, but it in turn will have to be adjusted to sound data as to fecal pollution to be obtained with improved methods of bacteriological analysis.

Treasury Department Standard

The so-called treasury department standard of waters used by interstate carriers—that is, with a maximum limit of 2 B. coli per 100 c.c., has a direct bearing also upon this question, as inevitably a safe loading upon water filters will also be limited by taking a certain assumed quality of output and then working backward from that result. Here, too, the reliability of methods of analysis, past, present, and prospective, comes clearly to the front.

Enough has been said to show that the art of sewage disposal is undergoing a change in its relation to water supply along what is believed to be sound and rational lines. Unfortunately the yardsticks for measuring the results are unquestionably crude, and subject to material improvement, to say nothing of the exceptions which may be exploited, to a normal relationship of sewage disposal and water supply. As a general proposition, however, the idea of predicating the solution of these municipal problems on the results which ought to be actually accomplished under various local conditions cannot be controverted.

Many Factors Combine to Cause Masonry Failures

In an address before the Engineers' Society of Western Pennsylvania, Prof. Horace R. Thayer, of the Carnegie Institute of Technology, discussed failures in masonry structures, and advanced the following general causes of such failures:

1. Ignorance

(a) **The employment of incompetent men in design and erection:** In view of the many ways in which the properties of concrete may be affected it should be kept under skilled engineering supervision from start to finish. Specifications should allow only skilled foremen to direct the actual handling of the material.

(b) **Supervision and maintenance by men without the necessary intelligence:** Fortunately, indeed, masonry is usually durable and continually growing stronger. In spite of the many things which have been enumerated which might cause trouble, it will, ninety-nine times out of a hundred, stand a great deal of abuse without serious injury. Reinforced concrete has yet to pass the test of long-continued use, but we feel a great deal of confidence in the outcome. Cases of overload and deterioration will probably occur at intervals, but the risk is very much smaller than that for steel or wooden structures.

(c) **The assumption of vital responsibility by untrained executives in charge of engineers:** The ranking engineer should be thoroughly competent to do any part of the work personally, and he should be the final authority in all questions pertaining to safety. Undue pressure for haste or economy ought not to be exerted upon him.

(d) **Competition without supervision:** Until human nature is changed we cannot secure a first-class, economical job by competitive bidding without complete specifications and an engineer to interpret them.

(e) **Lack of precedents:** This is likely to prove a prolific source of trouble in a material which has been so widely adopted in such a short space of time. Few accidents may be laid wholly to this source, in spite of the tendency of reinforced concrete designers to use rather high factors of safety and somewhat liberal assumptions. This indicates accurate methods of analysis on the part of the specialists engaged in this type of construction.

2. Economy

(a) **In first cost:** This, of course, is a familiar story to all engineers. Every effort should be made to place the material in the most efficient manner, but the question is how far it is permissible to reduce loads, increase allowable stresses, and make liberal assumptions.

(b) **In maintenance:** An accident, for this reason, is due to an error of judgment in allowing a deteriorating or failing structure to stand too long. Fortunately this happens very seldom in the case of masonry.

3. Lapses

Where an otherwise competent engineer has neglected one point.

4. Unusual Occurrences

For which it is not wise, everything considered, to provide.

Coming to the more specific causes, there are two which stand out more prominently than any others.

First, we have those failures due to faulty foundations. There are many cases of wholesale collapse of footings. There are also small, unequal settlements which often do serious damage. Masonry is very weak in shear and tension, and reinforced concrete is also lacking in this respect, if unforeseen forces are present. Now settlement often introduces just such forces. It is, therefore, axiomatic that masonry should be avoided as far as possible where the structure rests upon a yielding foundation. No matter how skillful the design, nor how closely the footings are computed for dead plus probable live loads, there are likely to be unforeseen inequalities in the soil, and the live load may average a great deal more upon one footing than upon another.

The second prominent cause is carelessness about deposition and mixing, especially in cold weather. When a warm spell follows low temperatures, we are very likely to hear of the collapse of a reinforced concrete building. This means that the concrete froze rather than set.

Col. J. W. Harkom, M.C.S.C.E., of Melbourne, P.Q., has just returned from England, where he acted as technical advisor to the Canadian Government in connection with the small arms branch.

Russian Engineer Appointed to Government Position

The appointment by the new Russian Government of an engineer—Professor Boris Bakhmeteff—to the office of Assistant Minister of Commerce and Industry indicates the progressive character of the new government, in that they recognize the need for direct representation of the engineering profession for active and efficient prosecution of the government and the war. Boris Bakhmeteff will be remembered by many members of the C.S.C.E. as the young Russian engineer who spoke before the Ottawa branch last October. He has had wide experience, including construction work on the Trans-Caucasian Railway and at the Simplon Tunnel. After the war began he came to New York as engineer-member of the Imperial Russian Supply Commission in America.

Letter to the Editor

Toronto, April 19, 1917.

Editor Contract Record:

Dear Sir,—Once again I take the liberty of writing the "Contract Record" to comment on the suicidal methods continued in the ornamental iron business. Some men in this business insist that they are getting a fair profit upon the work and contracts they are taking, but nevertheless there is no use disguising the fact that they, and most others in the business, are on their knees to their banks, their supply people, and their customers. And why? The answer seems to be the old story of the lowest tenderer getting the job. If this is a settled fact, and it is, except in rare cases, why do not the people who make these figures have enough nerve—yes, enough common sense, and, yes, common decency—to get what the work is worth? The latter because that enables him to be able to pay what he owes, and look everybody straight in the face.

One ornamental iron manufacturer said to me a short time ago: "If you are not satisfied with the prices you are getting put your prices higher." I have figured on at least $50,000 worth of work within the last three months, and have been underbid on it all. My prices were quite low enough in all cases, and in some too low. What is the result? Another season goes on with quite a good deal of the work let, and nobody any the better for it, and; more than likely, worse off than without it. I think the weak spot in the whole situation is that there is no proper cost system used, and that when work is proceeding, and coming to an end, the manufacturers have not the stern reality staring them in the face that their expenditure in labor and material is slowly closing in on the amount to be received for the job; and, even if the amount is sufficient to cover, there is not enough to clear your overhead expenses, which I have no doubt is figured at the old standard of twenty-five years ago—10 per cent.

Now, it seems a crime that so much brain and intelligence should be wasted in the ornamental iron business, because it requires brains to manufacture the goods, even if money is lost. But why should the money be lost? If these manufacturers would get together, so to speak, and compare notes, they could acknowledge to one another that they are not, and have not for some time, made a fair profit on their business, and resolve to place their figures on a basis comparing with the present prices of material and labor conditions. There need be no combination or anything of that sort—simply a resolve to place our business on a higher plane, where it will be a profitable business, and people in the building trade will look with respect on our branch, knowing that we know how to take care of ourselves. As it is, once the prices are in, the die is cast, and one unlucky individual gets the job because he is the lowest. Let us get together and see if we cannot get enough nerve in the ornamental iron business to see that the lowest is high enough to show a profit.

Yours truly,

W. Cowan.

The Daylight and Ventilation Company has been awarded the contract for sash-operating devices for the new plant of the International Nickel Company, at Port Colborne, Ont.

The Montreal Builders' Exchange have removed from Victoria Square to Suite 623, Drummond Building.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Method of Finishing Concrete Surfaces with Carborundum Brick

FIRST, remove the forms as soon as practicable after the concrete has been poured, and wet the concrete surface with water; for a railing, this will mean anywhere from 24 to 36 hours. Then with a sharp tool remove the lips and edgings left where form boards met.

Second, fill all holes with a 1:2 mortar at once. Then float all surfaces, where edges have been removed and where holes have been filled, to an even, uniform surface.

Third, allow the concrete to dry for a week or ten days after following the above procedure. The length of time required for drying and curing before rubbing with a carborundum brick depends entirely upon the weather, the length of time the concrete requires to harden, and to a certain extent upon the aggregate.

When the concrete has dried sufficiently, the next step is to treat the surface with a cement wash. To make the wash add enough cement to a pail partly filled with water to make the mixture of a creamy consistency. Apply this creamy mixture to the concrete surface with a brush, being careful not to apply too much at any one place, and at the same time enough to fill all the pores. No more surface should be treated in this manner than can be rubbed the following day.

After the cement wash has set twenty-four hours it should be rubbed off with a carborundum brick by applying water ahead of the brick with a brush, and working the brick in a circular manner. No attempt need be made to wash off the material that is ground off by the brick. This should be left in place and the curlycues straightened out with a dry or only slightly damp brush.

Care should be taken to rub off only the cement wash and no more, for if additional material is rubbed off the aggregate will be exposed. The purpose of the wash is to fill all voids and air holes that appear upon the surface when the forms are removed. The rubbing will not affect small holes that have been filled, but on the other hand will bring the whole surface down to an even, smooth finish of uniform color; something that cannot be obtained in any other way.

To facilitate the rubbing it is important that the concrete be well tamped at the time it is placed in the forms. It is equally important that the form lumber be in good shape, free from knot holes, slivers and splinters, for no amount of rubbing can remove these blemishes or marks.

Concrete which is too wet or sloppy should not be poured into the forms. If a soupy concrete is used, when the forms are removed the concrete has a sandy texture and is hard to smooth up. On the other hand, it should be reasonably wet and should be tamped into place rather than run into place with an excessive amount of water.

In railings and ballustrades it is quite important to use an excessive amount of rather fine sand and cement and not too much coarse stone. By doing this a much smoother railing will result.—By W. M. Conway.

Lime Replaces Cement in Concrete

CONSTRUCTION work in Aden, both public and private, has been very much curtailed on account of the abnormally high prices for all sorts of building materials. An interesting, though not entirely new, practice has developed in the execution of small but necessary pieces of work which would ordinarily involve the use of cement. In place of cement concrete, a mixture called lime concrete is being used. It is composed of equal parts of lime, sand, and pumice. The pumice is ground fine, and is obtained in unlimited quantities from the volcanic deposits that form the peninsula of Aden.

Lime concrete takes much longer to set than cement, but the results have so far been quite satisfactory. This material also is comparatively inexpensive. The chief engineer of the Aden Port Trust is now using it in a small and experimental way for construction which is covered by and consequently exposed to the action of sea water.

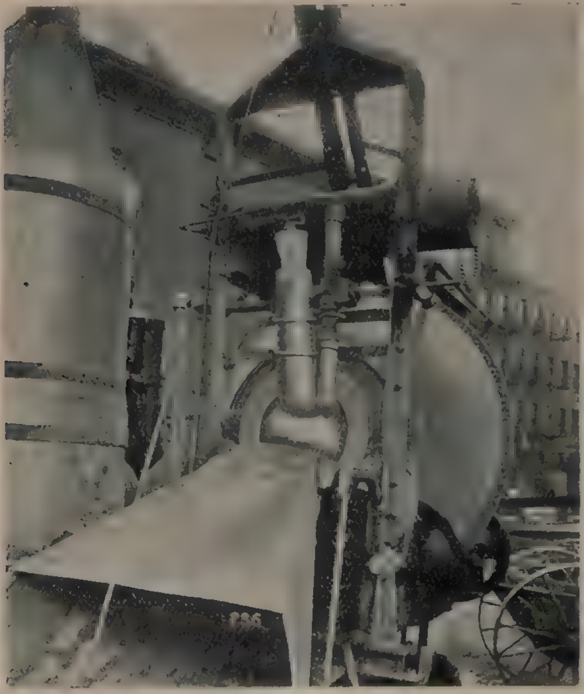
Two Air Tools Remove and Clean 250 Paving Brick an Hour

A portable gasoline-engine-driven compressor outfit supplying two small drills has been use at Troy, N.Y., to tear up brick pavements and clean the brick, at a total cost of $5.96 per 1,000, compared with a cost of $24 per 1,000 for doing the same work by hand, according to C. G. Cummings, in Engineering Record.

The outfit used is a single-stage 15-h.p. Sullivan air compressor supplying a 25-lb. plug drill and a hand-bushing tool of the same manufacture. The plug drill is used for tearing up the brick and the lighter tool for cleaning the old grout from them. Old pavements can be torn up at the rate of 4 square feet in 15 minutes, taking out one brick at a time or prying up several at once, as desired. Breakage is stated to be much less than when the work is done by hand. Previous to the development of this method it took ten men to tear up and clean 1,000 brick per day at a cost of $24. The operation of the compressor outfit, including oil and gasoline and the wages of an engineer and four workmen, cost $11.91 per day, and it is stated that the rate of progress with the two tools average 2,000 brick removed and cleaned in eight hours. Since this method was begun 767,000 brick have been cleaned with a total saving to the city estimated at $13,810. This is said to have paid seven or eight times over for the equipment, which is still in good condition.

Oil Burner Heats Concrete in the Drum

THE increasing amount of concrete work performed in cold weather demands some form of device to keep the material heated if success is to be assured. An oil heater for this purpose is illustrated herewith. It was first designed and built a little over a year ago, at the request of several contractors engaged on subway work in New York City. Tests conducted at that time on the apparatus are stated to have given the following results: Half-cubic yard heated to 50 degrees F. in two minutes; to 60 degrees F. in three minutes, and to 80 degrees F. in four minutes. The apparatus is attached to a concrete mixer, and uses fuel oil or kerosene. Two types are on the market. The compressed air type, as illustrated, is recommended wherever compressed air is available. The equipment comprises a 25-gallon oil storage tank, with oil and air regulating valves, filling pipe with plug and full unions. The tank can be placed on top of the mixer or wherever convenient. The burner is the atomizing type, requiring 15 cubic feet of free air per minute, and is so attached as to shoot the flame diagonally into the drum. The approximate oil consumption is 1½ gallons per hour. The burner starts instantly, without preheating.



An oil-burning concrete heater.

The other type is designed for use where compressed air is not available. It consists of a 20-gallon oil storage tank, which can be placed on the ground or operator's platform. A powerful hand-pump is provided to supply oil pressure which is required for operating the vaporizing type of burner. It requires about 90 seconds of pumping to obtain the necessary pressure of from 12 to 75 pounds. No air from the tank is necessary for vaporizing the kerosene in the burner, and pressure is only used to force the oil to the burner. The burner is arranged to shoot the flame diagonally into the mixer. The approximate consumption of oil is two gallons per hour. The apparatus can be started within five minutes after preheating.

A great many of these outfits are in use with excellent success on Canadian contracting jobs, for example, at the new plant of the Lincoln Paper Mills, Merritton, Ont., and the chemical plant of the British Chemical Company, at Trenton, Ont.

The apparatus described above is made by the Hauck Manufacturing Company.

Handy Extras for a Steam Shovel

THERE are two pieces of equipment that every contractor using medium or heavy excavating machinery will find a very good investment to have on hand. The first is a good chain block of from one to two tons capacity, which can be used in numerous ways. Around a steam shovel it has many applications in the reeling of cable or the picking up of heavy parts when making repairs. It can also be used in connection with the rolling stock for guiding cars into place, when dump cars are off the track, in straightening out a kink in the track between the trucks of a shovel, and in many other cases.

The other piece of equipment consists of at least one powerful jack, the size depending somewhat on the maximum weight of the machine on which it may have to be used. The experience of many erecting engineers in putting up different classes of machinery under every kind of condition has shown that a good easy-running ratchet screw jack is better for this class of work than the hydraulic jack, as there is less to get out of order and it is much more likely to operate properly, when suddenly needed. Where railroad type shovels are used, one jack of 25 or 50 tons capacity, depending on the size of shovel, will often help out in many ways. In the case of big draglines or coal-stripping shovels, two jacks of this size or perhaps one of 75 tons capacity will often save their price during one or two calls for their use. Two jacks are particularly serviceable where the machine has to be erected a number of times.

Examples of the usefulness of both the jack and the chain block are innumerable. In taking a shaft out of a gear, for instance, the jack may be used for pushing and the block for pulling. On coal stripping shovels it sometimes happens that a rail will break under one of the trucks; a 75-ton jack will save much time and money, as it is sufficiently powerful to lift up one corner of the truck and permit the replacing of the rail.

For general contract use a jack without a self-lowering feature is usually fast enough and is recommended because of its lower cost.

Economy of Metal Forms

When planning the form work for any concrete structure the possibility and desirability of using metal forms must be carefully considered. Forms of this type are adapted for work where the same units can be used a number of times without remodelling, or where they can be easily adjusted. On such work as sewers, subways, straight wall work, columns, etc., metal forms are usually economical. They are of doubtful advantage on building work, except for the round columns and column capitals or moulded work. There is so little in building work that allows the forms to be used over and over again that wood forms are cheaper and more economical than metal, even if the latter are leased. Special units are, moreover, frequently required, and these have no value outside that particular job.

The Water Powers of the Nelson River

Vast Undeveloped Power Resources with a Minimum of a Quarter Million Horsepower—Unexcelled Regulation—Data Compiled by the Commission of Conservation

The Nelson River flows through the central portion of northern Manitoba. Rising in the northerly end of Lake Winnipeg, it flows in a general north-easterly direction, discharging into the southwest corner of Hudson Bay.

The Nelson River, as the outlet of Lake Winnipeg, discharges the waters collected from an immense drainage area. It is one of the main drainage systems of the northern continent, having a tributary area of approximately 450,000 square miles. This vast area extends from the height-of-land, a short distance west of Lake Superior, to the Rocky Mountains. To the north, the basin is bounded by the Athabaska and Churchill watersheds, while the southern drainage extends down into the Northern States. Rivers tributary to Lake Winnipeg, and having immense areas of tributary drainage themselves, comprise such systems as those of the Winnipeg, Red, Dauphin and Saskatchewan rivers. Numerous smaller rivers, including the Berens, Pigeon, Manigotagan and Brokenhead, also contribute to the flow from Lake Winnipeg.

From the tremendous expanse of Lake Winnipeg and its tributary systems of great lakes, comprising Lakes Manitoba and Winnipegosis, a natural regulation of the flow of the Nelson River results, and the range between flood and minimum discharge is not high. In this respect, it is similar to the St. Lawrence, which is regulated by the Great Lakes.

General Description of River

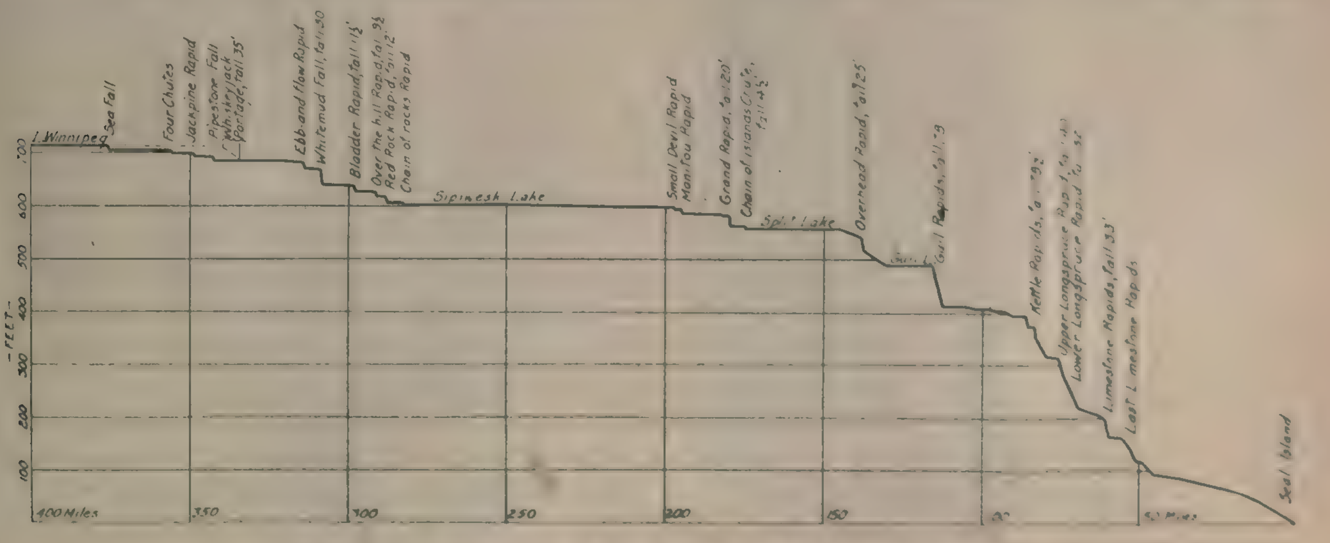
The length of the river from Lake Winnipeg to Hudson Bay is 430 miles. In this distance a descent of 713 feet occurs. The upper reaches of the river are more properly described as a chain of lakes connected by falls or by reaches of river and rapids. In this upper portion of the river, extending approximately to Split Lake, some 250 miles from Lake Winnipeg, the banks are in general higher than in the lower portion. Although the river, as stated, expands in this upper section into many lakes of slow-running water, yet the falls are more sharply defined and are usually of steeper descent than those in the lower reaches, and also are often separated by islands into numerous narrow channels. Not only are the banks lower as Lake Winnipeg is approached, but the distance between them increases. The descent in the lower portion is less abrupt, being more often a series of rapids or swift-running water. These latter characteristics gradually become more accentuated as Hudson Bay is approached.

Discharge Measurements

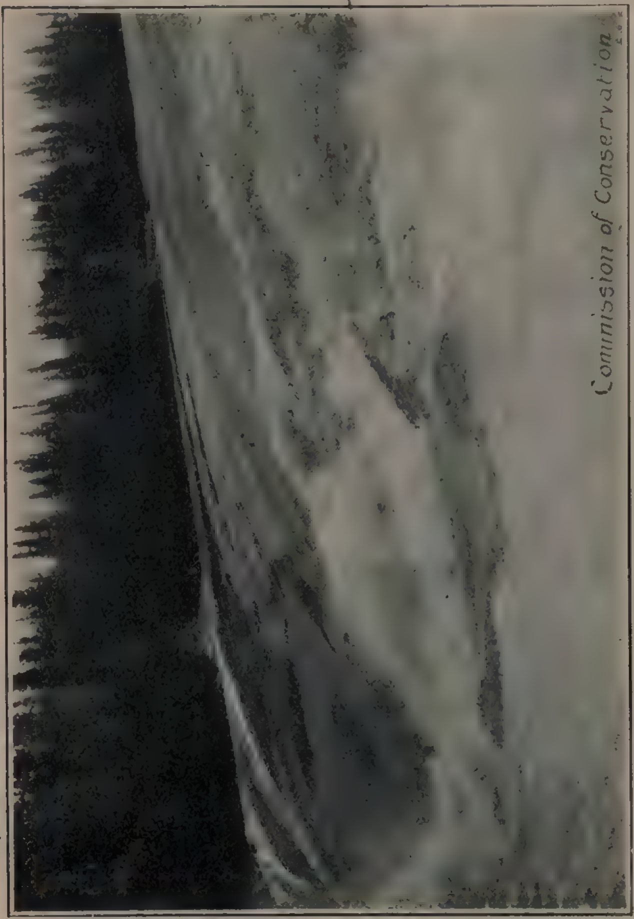
Several discharge measurements have been made on the Nelson River, though none of them, apparently, determine its low-water flow. Discharge measurements made by Mr. William Ogilvie in the latter part of August, 1910, in the vicinity of Whitemud Fall, indicate a discharge of 109,364 second-feet. Mr. Miles, of the Department of Public Works, obtained a discharge measurement at the outlet of Sipiwesk Lake on October 6, 1909, at what was stated to be a very low stage of the river; this recorded a flow of 118,369 second-feet. In September, 1913, measurements of the flow of the East and West rivers were made by Alexander Pirie, of the Manitoba Hydrometric Survey. On September 16, 1913, the total flow on the East River, below Sea River Fall, was 19,762 second-feet. On September 25, 1913, the flow on the West River, in the vicinity of Whisky Jack portage, was 46,549 second-feet. At the time of metering the West River, a storm from the northwest lowered the level of Lake Winnipeg at its outlet, which undoubtedly greatly decreased the flow. A regular metering station was established by the Manitoba Hydrometric Survey at the Manitou Rapid on July 18, 1914, and continuous readings secured till September 24 of the same year; the discharge during this period ranged from 87,000 to 103,000 second-feet. Records were also secured at this station during the winter of 1914-15, a low flow of approximately 45,000 second-feet being recorded.

As stated previously, any extreme variation in the flow of the Nelson River is hardly possible, due to the immense expanse of Lake Winnipeg, which offers unexcelled facilities for storage regulating the flow. The lake comprises an area of 9,414 square miles, and, in extent, ranks fifth in superficial area of the lakes of North America; it is over 2,000 square miles larger than Lake Ontario and slightly smaller than Lake Erie.

In considering the character of its rapids and falls, the

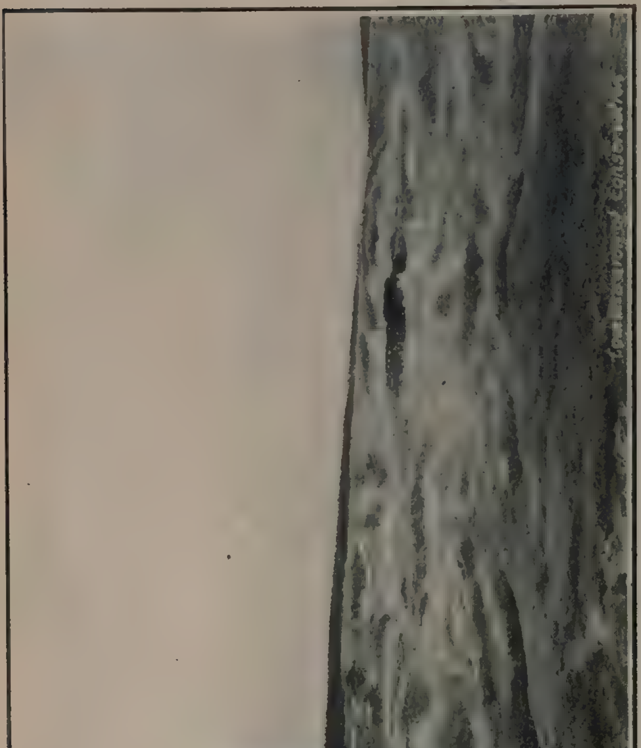


Profile of Nelson River—A fall of 713 ft. in 430 miles—50,000 c. f. s. minimum flow.

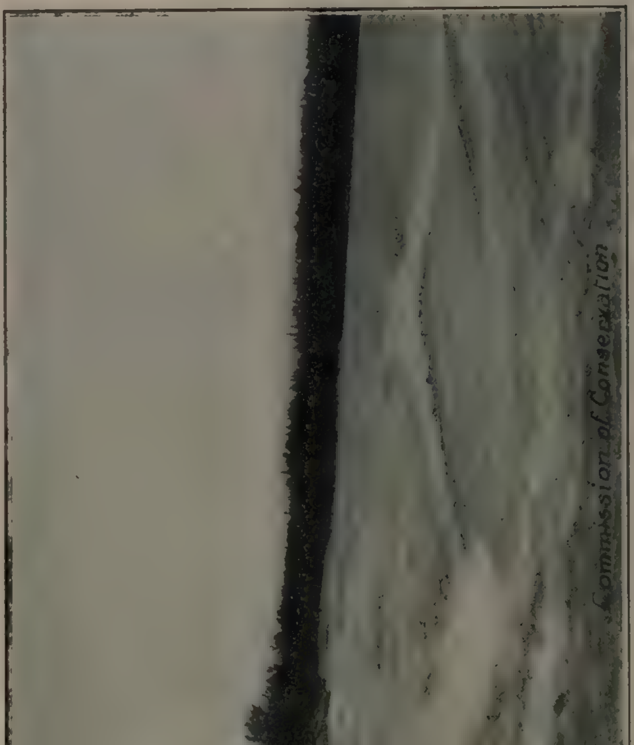


Nelson River—Whitemud Fall (West Channel)

Nelson River—Sea Fall (East Channel)



Nelson River—Grand Rapid (at Head)



Nelson River—Bladder Rapid

Nelson River—Ebb-and-Flow Rapid

Nelson River—Kettle Rapid

Nelson may be divided into three sections: (1) from the mouth to Kettle Rapids; (2) from Kettle Rapids to Split Lake; (3) above Split Lake.

In the lower portion, namely, below Kettle Rapids, it is generally very wide and free from islands where rapids occur. The rapids have a very gradual descent, are quite long, and, on account of the great width of the river, the prospects for power development are not very attractive.

In the portion between Split Lake and the foot of Kettle Rapid, there are many islands where the rapids occur. The rapids are steeper and, although, in some cases, the banks are rather low, this portion offers greater possibilities than the lower.

In the two sections just described, which include all the river below Split Lake, there is a practically continuous series of rapids and swifts. Even between rapids there are no still-waters; these stretches are either swift or rough.

Above Split Lake, the rapids and falls are well-defined, and their descents are generally steep as compared with those in the lower portion of the river. In this section, except above Pipestone Lake, the stretches between the chutes or rapids have very sluggish currents; the total descent in the river really occurs only at the chutes and rapids which, especially above Sipiwesk Lake, occur in numerous narrow channels separated by islands. Where these islands are situated, the river is quite wide, but the individual channels between islands are narrow. Power development in this part of the river should be accomplished easily; respecting the higher falls, i.e., those over eight or ten feet in height, there is no doubt that the total head can be utilized, while the chutes and rapids with less descent might be combined or used to increase the natural heads of the higher falls.

Herewith is a table giving the principal estimated water powers calculated on a flow of 50,000 c.f.s.:—

Nelson River Estimated Water-Powers

Power site	Head (in feet)	Available theoretical horsepower (May to Nov.)	Remarks
1st Last Limestone rapid	6	34,700	¾ m. long.
2nd Last Limestone rapid	15	87,000	1 m. long.
3rd Last Limestone rapid	10	57,900	¼ m. long.
4th Last Limestone rapid	10	57,900	1½ m. long.
Lower Limestone rapid..	8	46,300	⅛ m. long.
Upper Limestone Rapid..	25	144,700	¾ m. long.
Lower Long-spruce rapid.	52	301,000	4 m. long.
Upper Long-spruce rapid	40	231,500	2 m. long.
1st Kettle rapid	40	231,500	3 m. long.
2nd Kettle rapid	21½	124,500	½ m. long. H B Ry crossing
3rd Kettle rapid	17	98,500	100 yards long
1st Gull rapid	20	115,800	1 3 m long Head could be raised to 30 feet
2nd Gull rapid	20	115,800	500 yards long
3rd Gull rapid	21	121,500	250 yards long
4th Gull rapid	17	98,500	⅛ m. long.
Overfall rapid	25	144,700	½ m. long.
Chain-of-islands chute ..	4½	25,500	300 yards long. Possible head 8 feet.
Grand rapid	20	113,500	160 yards across portage. Possible head 26 feet.
Maniton rapid	25	142,000	Head created by dam.
Red Rock rapid	12	68,000	900 yards long
Over the hill rapid	9½	54,000	Possible head 13 feet
Bladder rapid	11½	65,500	900 yards long
Whitemud fall	30	170,000	500 yards across portage
Ebb-and-flow rapid	9½	54,000	
Whiskey Jack portage ..	35	200,000	

The Toronto city council have adopted the civic estimates for 1917, totalling $19,034,480. The item covering $50,000 for an activated sludge experimental plant was struck out, as was also the item of $642,991 for school sites and additions to buildings. The $40,000 for the operation of Riverdale incinerator was allowed to remain and the appropriation for road oil was increased from $18,000 to $30,000.

At a recent meeting of the council of Sarnia, Ont., the contract for the paving of London Road was awarded to McCrae and Campaign, of Niagara Falls, at $25,695.

Mainly Constructional

East and West—From Coast to Coast

The Crown Construction Company, Limited, has been incorporated with a capital of $20,000, head office at Westmount, P.Q.

A scheme is afoot in Regina, Sask., for the construction of paved roads running fifteen miles north, south, east and west from the city limits.

Announcement has been made regarding the erection of a new $150,000 hotel in Moncton, N.B., and it is stated that work will be commenced shortly.

The village of Peace River has been authorized by the provincial government of Alberta to borrow $5,000 for the construction of sidewalks and roads and purchasing fire equipment.

To relieve congestion in the Solid Leather Shoe Company's plant at Preston, Ont., and place it in a position to fill orders more promptly, a large addition is being built to the company's factory.

The village of Spirit River, Alta., has been authorized by the provincial government to borrow the sum of two thousand dollars for the purpose of obtaining a water supply and fire protection for the village.

The rural municipality of Dauphin, Man., is submitting a by-law to the ratepayers of a portion of the municipality for the purpose of raising money to construct, under the Good Roads Act, 16 miles of gravel road and 8 miles of earth road.

Work is being commenced on a saw mill and cannery, located on the Louis J. C. Matthews property, comprising five acres at the outlet of Nitinat Lake, B.C. Mr. J. S. Rice, of the Lummi Bay Packing Company, Bellingham, is head of the group of capitalists who control the enterprise.

Works Commissioner Harris and Finance Commissioner Bradshaw have strongly recommended to the works committee that the city of Toronto should incur no further expense in connection with the Toronto-Hamilton Highway until some definite statement of the cost was forthcoming.

The Aviation Department of the Imperial Munitions Board is establishing an aviation school at Deseronto, which will be known as Camp Mohawk. The camp is being built on the large Indian plains about two miles from the town, on the shore of the Bay of Quinte. The school will be in operation about June or July.

The Department of Public Works of the Province of Manitoba propose to construct a gravel road in the municipality of St. Francis Xavier at a cost of $165,000. About $200,000 is also to be expended on road construction work in the rural district of Portage la Prairie, and an equal expenditure is contemplated in the municipalities of Archie and Pipestone.

The board of control and works committee of the city of Hamilton, Ont., have endorsed the joint report of Engineers Gray and Bain, which recommends the installation of a steam turbine centrifugal pump of 10,000,000 gallons capacity, and another electrical unit of 10,000,000 gallons capacity. It was estimated that the new equipment for the waterworks plant would cost in the neighborhood of $103,000.

At the annual meeting of the Building Trades Federation in Winnipeg recently, the following officers were elected: Alex. Taylor, of the Stonecutters' Union, president; Andy Young, of the Structural Ironworkers, vice-president; C. J. Harding, Carpenters' Brotherhood, financial secretary; A. R. Johnston, recording secretary; E. A. Thorpe, treasurer. A business agent was also appointed, James Winning being chosen for the position.

Plans for a permanent approach to the Fraser River Bridge, Vancouver, by the construction of a concrete wall 40 feet high and filling in behind it, have been approved by the city council. The estimated cost is $18,000. The plans will be submitted to the Provincial Minister of Public Works, as it is thought that the government should carry out the work, which is necessitated by the threatened collapse of some ancient cribwork.

The Provincial Government of Saskatchewan at the last session voted some $300,000 for road construction work, and some $110,000 for steel bridges. The method of procedure in Saskatchewan, as laid down in the Act recently passed, is to have the road work carried out by the municipalities under contract with the government, after the Highways Department has received assurance that the municipality has the necessary equipment and is in a position to do the work economically.

Two deputations waited upon the Ontario Government recently regarding the route of that section of the proposed provincial highway between Toronto and Windsor. One deputation urged the advisability of locating the highway along the Woodstock, Ingersoll, Brantford and Hamilton line, while the other advocated the Guelph-Kitchener route. The Premier assured the delegates that the location of the proposed highway would be governed entirely by the final results of the comprehensive investigations and surveys now being made by the government engineers and officers.

A further increase in the fees on building permits is suggested as a source of additional revenue for the city of Toronto. Last February a by-law was passed by the city council making a raise in the permit fees which amounts to an increase of $300 on every $1,000,000 worth of permits. The old fees resulted in a collection of $900 per $1,000,000 in permit values, while the new schedule brings in $1,200. However, the city architect, Mr. W. W. Pearse, believes that a much greater increase could be made than that recently instituted. The total revenue from fees on building permits averages $25,000 per annum at present.

The administration board of the Greater Winnipeg Water District at a recent meeting decided to defer letting the contract for cast iron pipe, valves and specials for the Shoal Lake water main from the Red River to the McPhillips Street pumping station, for the present. They point out that if the Red River tunnel work and the laying of the cast iron main were completed an unnecessary length of time before the completion of the other work the District would be paying interest on the cost of labor, material, etc., which otherwise could be saved; it would be inadvisable perhaps to contract on a high market for material which under certain conditions may not be required for another year.

Personals

Mr. Hamel, C.E., has been appointed assistant city engineer of Quebec, P.Q.

Sir Henry Egan has succeeded the late Sir Henry Bate as chairman of the Ottawa Improvement Commission.

Mr. James Stables has been appointed chairman of the Vancouver and Districts Joint Sewerage Board, succeeding Mr. Frank Bowser, who has retired.

Mr. R. E. W. Hagarty, A. M. Can. Soc. C. E., has been appointed by Messrs. MacFarlane, Pratt & Hanley as engineer in connection with the construction of a 1,000,000-bushel reinforced concrete elevator at Midland, Ont.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 May 9, 1917 No. 19

Principal Contents

Page
Editorial 407
Steel Joined on Bloor Street Viaduct, Toronto 409
Municipal Engineering Requirements 413
Two Montreal Schools 415
Modern Road Making Machinery, its Selection, Use and Care 416
Determination of Weight per Cubic Foot of Sand 418
Preferable Methods of Grade Crossing Elimination ... 419
To Make a New Surface Stick to an Old Concrete Floor 420
Practical Hints for the Contractor 421
The Manufacture of Munitions as a Permanent Asset to Canadian Industry 423
Mainly Constructional 426

The Engineer and the Labor Problem

"ENGINEERING methods must replace paternalism in the handling of labor." This head line to an article by Miss Frances A. Kellor, in a contemporary, is an expression of a new idea of social responsibility that is to be assumed by the engineer in the near future. Miss Kellor, who is assistant to the chairman of the Immigration Committee of the United States Chamber of Commerce, has had unusual opportunity for, and wide experience in, the study of industrial relations and the methods of coping with the labor problem. Her article, referred to above, is a very scholarly presentation of the changes that are taking place in industrial-relations management. Her contention is that to permanently solve the complex and difficult problem, the engineer is the only logical executive. In the matter of handling labor, with all its diverse complexities, scientific planning, it is prophesied, will have to be applied.

This may seem going far afield from the engineer's usual sphere of action. It may appear an uncalled for transgression into the realms of sociology, perhaps a wanton alienation of engineering ability. Yesterday this might have held true, but to-day we must not regard the engineer's place as too limited and prosaic. The trend of modern thought is all along the line of a wide field of action for the engineer. We hear continually of the engineer's place in politics, of his greater responsibility in national and community life. But this only goes half far enough, or rather it goes too far, for it leaves open a wide chasm. By filling this gap, the engineer would be performing a duty quite in keeping with his larger vision. This duty is the improvement of the industrial-relations problem.

* * *

Hitherto, this matter has been in the hands of the politician or the welfare worker. They look at it, though, from a very socialistic viewpoint, at most as a matter of sentiment, benevolence, or natural-growth reform. Their outlook upon it does not consider the causes that produced the need of an industrial-relations management; they regard only the effect. The engineer, however, has been a fundamental influence in creating such a need. The fact that there is an industrial-relation problem to solve is a result of a highly complicated organization binding worker to capital. This organization of production is a product of mechanical and human elements. The bent of modern industry is towards a multiplication and consequent intricacy of machinery. The unit measure of modern industry is the machine; it is the predominant link of the great industrial production chain. All endeavors have been focused on the improvement of the mechanical element, to its greater efficiency, and its greater productive capacity. These reformations and reorganizations seemingly fail to observe the more humanized side of the matter. The human element and the mechanical element are but complements of one another, and a concentration of effort has been applied to the one without an attempt at a corresponding completion of the other. The result has been that the human side of the industrial relation problem is subordinated and allowed to lag behind the mechanical development.

* * *

The engineers have been the prime movers in instituting mechanical improvements and developments. They try to increase machine output at less cost or with fewer men. They build plants that are marvels for convenience of routing, or location of processes. Their efforts have been mainly material. They have concerned themselves little with the human fabric of the web. And it has been these material discoveries that are largely responsible for the industrial and labor problem, for so tied up are the human and machine elements that the very life of the one is dependent on the other.

The problem of industrial-relations management is simply one of adjusting the human factor in the complex production organization of industry, of correlating the two elements in the proper fashion and of promoting a more social and equitable environment.

Heretofore the solution has been in the hands of the benevolent-minded and the philanthropists. The engineer has not, or was not, asked to contribute his opinions or experiences. But, as Miss Kellor states, "this field is primarily one for the engineering executive." If for no other reason, because it has been by the engineer's work in the perfection of the mechanical element of production that the need of a labor adjustment is made obligatory. The conditions under which labor has been employed have been created by the application of scientific training to the material environment of the worker. Why should not this same talent be applicable to the more human surroundings with an unmitigated success?

The methods of solving labor conditions seem, in Miss Kellor's opinion, to require the organization ability and practical scientific mind of the trained engineer. The material element has been developed by a logical process and evolution and the same logic seems no less proper for the human element. In all its phases, then, whether of employment, promotion or housing, scientific principles should be applied. This opens a further fruitful field of endeavor for the engineer. His acceptance of its possibilities will bring him to the focus of a mighty change in social responsibilities. He will be the pilot that guides the wheels of industry.

Churches and Schools the Bulk of Montreal's Building

FROM present appearances the chief portion of the building work in Montreal will be, like last year, on churches and schools, with a little construction on munition plants. Materials have lately advanced in cost right along the line, and in certain directions are also scarce; labor, too, is dear, and the men in some trades are demanding still higher pay. This has a tendency to restrict building, although the permits and the values show a large increase over last year.

In the opinion of some contractors there is no prospect of any substantial decrease in the cost of building for at least two years, and those who contemplate building should face the situation. For a long time after the commencement of the war, there was a very dull period in the contracting line, many people being afraid to commence operations owing to the uncertain outlook as to the course of hostilities, although prices were very low. Subsequently, under the stimulus of munitions work, contractors were able to advance quotations, but even then much building was postponed in the belief that prices would revert to something like a normal basis. The contrary has proved to be the case, and the cost of building has consistently risen. It is true that land values have receded from the high-water mark reached during the boom days, but this circumstance is more than balanced by the all-round advance in materials and labor.

The Contract Record strongly advocated construction work during the dull period referred to, and those who took advantage of this advice were able to obtain cheap building. It looks as if the higher level of prices has come to stay for some time, and that those who desire to build will not get better terms by postponing work. The rebuilding of the devastated regions in France and Belgium will involve a heavy call on the resources of the world, making for high prices both on this continent and in Europe.

So far as the Province of Quebec is concerned, the bulk of the contracts this year are for churches and schools, together with some factories and additions to existing pulp and paper mills. There is a number of residences to be erected, although it is argued by some people that the cost of this class of building is so high as to preclude anything like a profitable return on the investment. Tenders for a considerable number of small bridges have been invited. Two or three filtration schemes are also to be carried out.

Untrue Cost Reporting

THERE is a vast deal of untrue cost reporting in this day and generation. By untrue we mean simply incorrect, whatever the underlying cause or motive. Much of this untruthfulness is due to unintentional incompleteness through ignorance, blundering, or laziness, but some is deliberately designed to deceive. Engineers who value their reputation for scientific accuracy and for professional honesty should fight untrue cost reporting, regardless of its origin or object.

Flagrant examples of untrue cost reporting are apt to be found after changes from private to municipal ownership of waterworks and other public utilities. In such case it is very common for cities to claim profits under municipal ownership, sometimes after considerable reductions in rates, when the fact is that inadequate allowance, and in extreme cases no allowance at all, has been made for capital charges. Similarly, cities changing from street cleaning or garbage disposal by contract will compare contract prices with the "cost" of the municipal service, and make absolutely no allowance for interest and depreciation on plant and equipment. An example of this occurred in the first statement of the results of the operation of the Cleveland garbage reduction works under municipal ownership, although a footnote naively gave warning to the wary that interest on bonds was not included because it was taken care of by another city department. Later reports, it is only fair to say, included an allowance for all capital charges.

Engineers can appreciate the obligation of cities to include capital charges whenever comparing public with private ownership of utilities, or results under contract construction of sewers or pavements or contract service in street cleaning, garbage collection, and disposal with force-account results. The average city official, however, seems unable or unwilling to take all the elements of cost into account when he is reporting the cost of almost any service rendered by a city. What city accounts, to go into quite another field than any of those mentioned, include in the statement of cost of the public schools the interest charges and depreciation on the investment in school buildings?

Since the engineer can and does appreciate all the elements of cost far better than the average city official or citizen, he should take pains to see, each in his own city or state, that true and full costs are reported instead of dishonest or partial costs.—Engineering News.

The Legislative Committee of the Montreal Council has been asked to report on a proposal, favored by the Board of Control, for the city purchasing sandpits and quarries. The same committee is asked to report on obtaining powers to control the height of outside staircases to dwellings as well as power to enforce the povision of rear exits. The idea is to limit outside staircases to a height of five feet, communication with upper flats being obtained by staircases inside the building.

Steel Joined on Bloor Street Viaduct, Toronto

Another Stage in the Completion of Big Bridge—Contractors are Ahead of Schedule — Rosedale Section Practically Finished—A Review of Past Progress—Steel Erection Methods

THE steel of the Bloor Street viaduct, Toronto, was finally linked up according to schedule on May 1, so that, with the Rosedale section practically completed some time ago, the bridge is now continuous from end to end, although several months from a traffic-bearing stage. The first sod was turned on January 16, 1915, and the time allotted by contract for the completion of the work expires on December 24, 1917. The Rosedale section was finished with the exception of the paving, track laying and lighting arrangements, some time ago, and operations will now be concentrated on the Don section and the Bloor fill section, which forms the western end of the viaduct. Details of design and construction with progress reports have appeared in the Contract Record of July 15, 1914; October 28, 1914; November 18, 1914; December 15, 1915, and July 12, 1916.

This viaduct, the purpose of which is to link the north-eastern section of Toronto with the central and western portions, separated otherwise by the deep Don Valley and the subsidiary Rosedale Ravine, has an entire length of 5,267 feet, from Bloor and Sherbourne Streets, the western terminus, to Broadview and Danforth Avenues, the eastern extremity. The bridge divides itself into three main sections; an earth side-hill fill, 1,564 feet long, paralleling the Rosedale ravine, and two bridge sections known as the Rosedale and Don sections, crossing the Rosedale Ravine and Don Valley respectively. A paved roadway will cross the projection of land that separates these two valleys and will connect the two bridge sections. The earth side-hill has been adopted at the western end to avoid a long expensive bridge which otherwise would be required to cross the ravine at a very acute angle. By deviating the route along the ravine for a short distance, a bridge crossing it at nearly right angles is made possible. The fill is being gradually performed and tenders will be taken for its completion if free fill and excavation spoil does not prove sufficient.

The bridge proper is a steel arched structure carried on reinforced concrete piers and with reinforced concrete approaches. The main spans are four-ribbed three-hinged steel arches. The bridge measures 86 feet wide out to out of handrailing with two cantilevered sidewalks 10 ft. 9 ins. wide and a roadway 64 ft. 6 in. curb to curb with two car tracks. It is a double-deck structure, the difference in elevation of grades of the lower and upper deck systems being 22 ft. The lower deck which is to provide for future subway traffic will not be finished at present. In the Don section, there are five main arches with one in the Rosedale section. They are carried on cast steel pin grillages set on granite blocks in the skew-backs of the piers. The floor supports are I-beam stringers. Lattice girders on the end of the deck system carry the hand railing.

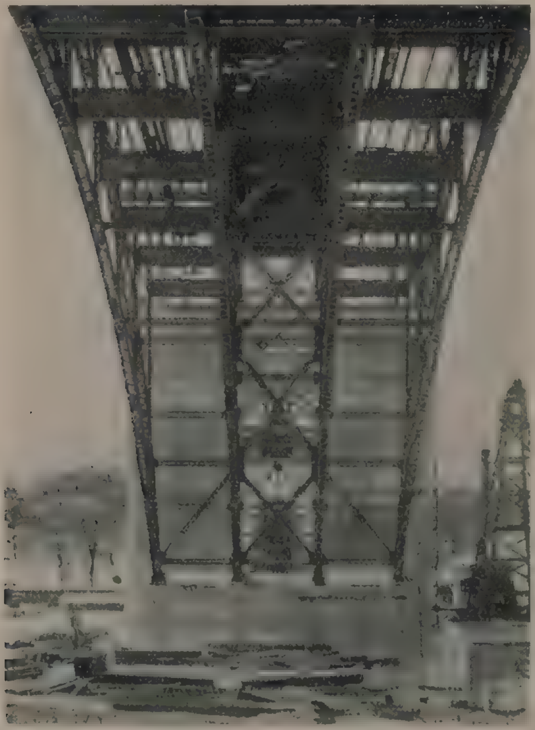
The eastern portion of the viaduct, crossing the Don valley and known as the Don section, connects Danforth Avenue with a projecting point of land between the two ravines. Its length is 1,680 ft., including the approaches. The arches total 1,077 ft. 6 in. There are five main arches, two of 158 ft. span, two of 240 ft. span and one of 281½ ft. span, all measured from centre to centre of pins. The height above the Don river is 125 ft. The western approach contains a small 80 ft. steel through-truss span masked with concrete side walls and suspended concrete ceiling. The eastern approach and the remainder of the approach work on the west comprise steel frame work with deeply panelled concrete wall coverings which give the effect of very solid and massive concrete abutments.

The main piers, B, C, D, and E. (lettered from the east), are carried down to bed rock which ranges from 29 ft. to 47 ft. below ground surface. Excavation for these piers was performed by the open caisson method, Lackawanna steel sheet piling and timber sheeting being used, with heavy bracing to prevent the caissons from caving in. Pulsometer pumps were used in general for unwatering, which was quite a job in the two piers on either side of the Don. Hayward buckets did the excavating. The rock at this location is of a shaly nature, the top strata of which were soft and disintegrated. This necessitated a bedding 2 or 3 feet further down to secure a firm foundation. The deepest excavation was 47 ft. below the lowest level of the Don Valley. The piers A, F and G, at the two approaches, are of the mattress type on hard, dry clay foundations varying from 10 to 14 ft. below the surface of the ground. The only serious trouble encountered during the construction of the piers was deep layers of quicksand saturated with water, necessitating rigid and tight fitting forms. The total excavation amounted to about 45,000 cubic yards. The spoil was handled by an aerial tramway 1,200 feet long, spanning from the east bank of the Don to a point just past the west abutment at an elevation 125 ft. above the valley bottom.

Steel arches were erected on timber falsework by travellers and guy derricks.

The concrete for the piers was placed from five hoist towers and chutes located opposite piers B, C, D, E and F. The mix was 1:2¾:5½ for the foundations and 1:2½:5 for the bodies. Relaying concrete from tower to tower was carried out in some instances. The piers are solid to the skew-backs and are hollow concrete-faced above that point with steel frames carrying the loads. This construction gives the appearance of very solid piers up to deck level.

The concreting plant comprises five concreting towers with a mixing outfit for each with the aerial cableway for transportation of aggregates, etc. Each tower is provided with a derrick boom. There are three railway lines in the Don Valley crossing the line of the viaduct. The Canadian Pacific Railway tracks run parallel to the river about half way up the hill on the eastern side of the valley. The G. T. R. and C. N. R. lines are in the bottom of the valley just on the west bank of the Don. The proximity of these lines made it a very easy matter to transport material and equipment. The aggregate for the east side of the Don section is delivered on the sidings of the C. P. R., unloaded by clamshells and delivered to the bins at the foot of the east tower, opposite pier B, which is the only tower served from this siding.



The bridge comprises four-ribbed, three-hinged steel arches. Underside of one arch looking toward concrete pier.

For the western portion of the bridge, the railway lines in that side are used for the delivery of aggregate which is unloaded by clam shells into storage bins or piles alongside the track. From there it is distributed by the cableway to the mixers at the foot of each tower. Cement is unloaded onto narrow-gauge hand trucks and stored in sheds. Distribution to the mixers is by means of the cableway.

An up-to-date plant is located at the east side of the river. It includes a carpenters' shop, blacksmiths' shop and a machine shop. Storehouses and boarding rooms for the men were erected during the early part of construction. The main water supply for drinking, boilers and concrete work is brought from the city mains on Danforth Avenue. In general the plant is steam driven. A few small motors, however, are used for driving some woodworking machinery and small tools, a small electric equipment being necessary.

The steel work was erected on the Don section on falsework by two travellers and by guy derricks. The steel for the eastern end of this section is delivered to the sidings of the C. P. R. and unloaded by a 20-ton guy derrick with an 85-ft. mast and 60-ft. boom, which was also used to erect part of eastern 158 ft. arch. The steel for the west end of the bridge was delivered on the G. T. R. and C. N. R. railway' lines, which, however, were 700 ft. from the west abutment. The aerial cableway was used to unload and transport about 450 tons for the west approaches. For the west 158 ft. and 240 ft. arches, the falsework was partially erected to a certain elevation and a temporary track 360 ft. long laid on it. Another 20-ton guy derrick, also with an 85-foot mast and 60-foot boom, erected in a convenient location, unloaded and raised the steel to trucks on the temporary track, where it was moved into a position for the travellers to handle.

After the approach work was completed on either side two travellers were set up and performed most of the erection aided by the guy derricks referred to. The travellers were of the twin derrick type. Each measures 18 ft. 6 in. centre to centre of trucks, and is fitted with two 60-ft. lattice-work booms built in three sections. The lifting capacity is 12 tons in any position. The centre section of 20 ft. is withdrawn for handling heavy loads, the capacity in this case being 20 tons. A four-drum 8 in. x 10 in. hoisting engine operates the traveller.

The traveller was used to erect the entire west 150 ft. span. The corresponding span on the east side employed both the traveller and a guy derrick. For the 240 ft. arches, the traveller and 20-ton guy derricks worked in conjunction. These spans were so long that the traveler could not reach out far enough to complete the arch until the derrick had erected a great part of the opposite side of the spans. The centre 281 ft. span was assembled simultaneously from each side, using only travellers. The steel met on May 1, so that the steel is now continuous from end to end. There are very nearly 6,000 tons of steel in the Don section.

Deck of the Rosedale section minus car tracks and paving. The Don section will be identical in appearance. Total width is 86 feet.

All of the steel was assembled on falsework. This was made of 12 x 12 and 10 x 18 Douglas fir timbers in standard sections with caps, sills and platforms uniform, so that assembly was possible with very little waste. All bents were framed before being used. Provision was made for jacks under each panel point for raising or lowering the ribs. The falsework was built up as required and as the arches progressed. The erection travellers were employed to a considerable extent in raising the falsework and a stiff-leg derrick when the traveller was found impracticable.

When the travellers are not further needed both will be run to a point over the G. T. R. tracks at the west bank of the Don and one will disassemble the other and lower it to the cars below. A derrick will then be erected to disassemble the second one and lower it to the railway tracks.

The pin joints for the spans are steel castings set on granite blocks imbedded in the concrete piers and held with two anchor bolts. As stated, the piers are solid up to the skew-backs only and hollow above this. The assembly of the steel began as soon as the piers had reached the skew-backs and the pin grillages were set. The remainder of the pier was continued later.

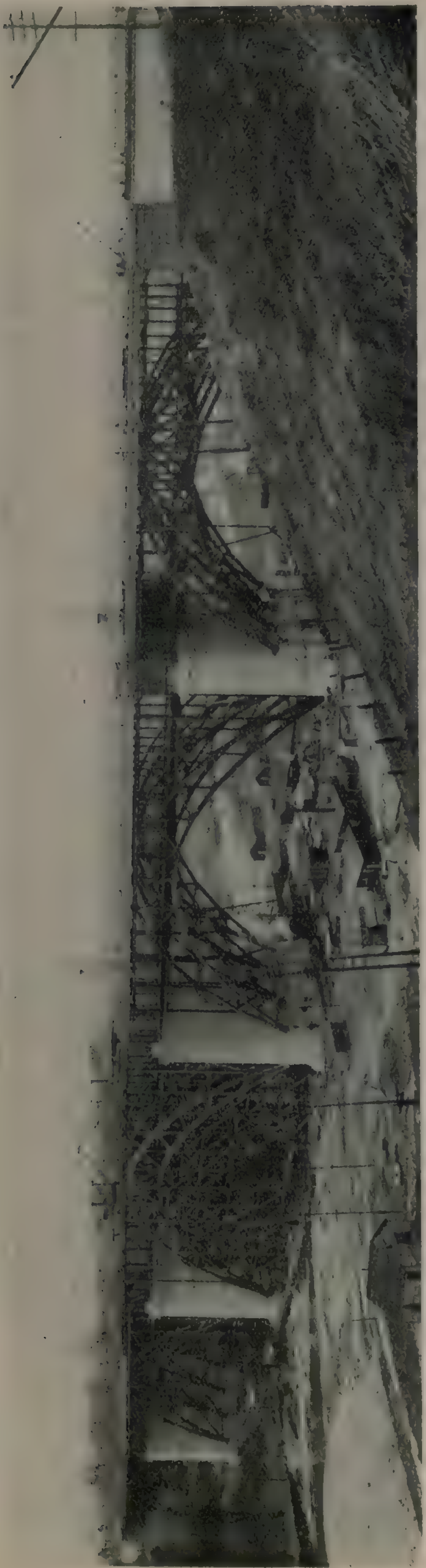
All concrete work is given a smooth finish. The forms are removed when the concrete has sufficiently hardened and all projections are removed with chisels or other steel tools and all holes are plugged. The surface is then polished with carborundum blocks, by either hand work or using electrically-operated tools. The final treatment is an application of a cement sand plaster. This gives a smooth, uniform finish. The total amount of concrete on the Don section will be about 43,000 cubic yards. The reinforcing steel amounts to 492.6 tons.

The Rosedale section of the Bloor Street viaduct is 600 ft. long and 95 ft. above the roadway in the Rosedale Ravine. There is but one span, an arch measuring 190 ft. from pin to pin with a rise of 64 ft., similar in design to the arches in the Bloor Street section. The western approach contains an 80-ft. span, comprising through trusses, masked with concrete sidewalls and suspended ceiling. The approaches on this section are enclosed in concrete, similarly to the Don section, thus giving a massive effect. The northwesterly side of the bridge is placed on a curve of 315.6 ft. radius. There is a retaining wall on this approach 160 ft. in length. This is of the buttress type for 60 ft., the remainder being of the cantilever type.

There are three main piers in this section, known as H, I and J. Piers H and I are carried to a point three or four feet below rock surface to obtain a solid foundation. The depth is about 35 ft. below grade. Pier J and all minor piers rest on clay.

The concreting was carried out with two towers and chutes. The steel was erected by derrick on this section. Owing to the lack of railway transportation all materials had to be hauled and then handled by derricks instead of by aerial cableway as on the Don section. This section is now finished except for the paving and car tracks. The excavation for this bridge was about 31,000 yards. The concrete work amounted to 16,000 yards; the structural steel to 1,300 tons and the reinforcing steel 225 tons.

The deck of the bridge is of reinforced concrete using a 1:2:4 mix. Twenty expansion joints are provided in the floor of the Don section, and 8 in the floor of the Rosedale section. The work is just commencing on the floor of the Don section while that on the other is completed. A creosoted wood block paving in a mortar cushion will be laid.



The Don section of the Bloor Street Viaduct, Toronto, viewed from the southeast, after the joining of the steel at the middle. Work was performed on the two ends simultaneously. The travellers are shown placing the last floor stringers in the centre span. This section comprises five arches, with concrete piers and approaches, and concrete deck. The total length over approaches is 1,680 feet and the over-all width is 86 feet. The maximum height is 125 feet.

The handrailing, which amounts to 3,283 lineal ft. on the Don section and 1,260 lineal ft. on the Rosedale section, is carried on lattice girders which are enclosed in concrete. It is of concrete using a 1:1:3 mix, the aggregate being a crushed red granite. After the forms are removed, the surface is acid treated to eat the concrete from around the granite. This leaves a rough finish with a reddish cast. The sidewalks also carry a reinforced concrete curtain wall.

As has been stated, the massive effect is produced in the approach work by the use of concrete facings to the steel framework. The abutments comprise steel columns spaced 20 ft. centre to centre along the axis of the bridge and 22 ft. transversely, these columns being carried on reinforced concrete pedestals. Concrete side-walls cover the steel work with lateral ties to stiffen the wall against the flexure. There is ample provision for expansion. To give relief to the large areas, the concrete is deeply panelled. In the piers the steel columns are spaced 16 ft. 6 ins. and covered with reinforced concrete masked walls. The short 80-foot span at the west end of both the Don and Rosedale sections have steel through trusses with reinforced concrete side-walls carried on buttresses forming part of the main piers. The soffit is suspended from the bottom cords of these trusses..

The Rosedale section. Reinforced concrete side walls covering steel frame give massive effect to abutments on both Rosedale and Don sections. Handrail is of concrete.

The south-east side-wall on the Rosedale section, owing to special conditions is made in the form of a vertical slab with girders and beams in the vertical plane.

The work is being carried out under the direction of the City Department of Works, of which R. C. Harris is Commissioner and G. A. McCarthy, chief engineer. The general contractors for the Don section are Quinlan & Robertson, whose contract price was $947,076. The Hamilton Bridge Works are the contractors on the steel work. T. T. Black is resident engineer for the general contractors. The general contractors for the Rosedale section are the Dominion Bridge Company, whose contract price was $298,555. The Raymond Construction Company were the subcontractors on the concrete work.

Suppliers of Material and Equipment

On the Don section the following firms supplied materials:—Albert Rogers, Ltd., cement and crushed stone; Steel & Radiation, Ltd., expanded metal; Steel Co. of Canada, reinforcing bars; W. G. Godson Co., Greenburn, Ont., sand; Dominion Steel Foundries, Hamilton, steel castings; Canada Cement Co., cement. The following equipment was also used:—Beatty hoists; Hayward buckets; Ransome & Smith mixers; Marion steam shovels; Ingersoll-Rand air compressor plant; Doty hoists; Lidgerwood cableway.

On the Rosedale section materials were supplied by the following firms:—Canada Cement Co., cement; Baines & Peckover, reinforcing steel; Lake Shore & Gravel Co., sand; Albert Rogers, Ltd., crushed stone. The equipment included:—Smith mixers, Beatty hoists, Thew shovels, Adams dump wagons, Greening wire rope, Owen clam shells, Lakewood dump buckets, Ingersoll-Rand air compressors.

Council of R. A. I. C. Meets

THE Council of the Royal Architectural Institute of Canada met in Ottawa on April 28, under the presidency of Mr. J. P. Ouellet, of Quebec. The meeting was very well attended, including a member from Alberta. It was decided to hold the annual meeting in Ottawa on the 1st and 2nd of October next. This will be the tenth gathering; originally the organization was known as the Institute of Architects of Canada, and in 1909 permission was given to use the prefix "Royal." Three years later the Institute secured a charter for affiliating all existing architectural societies who possessed provincial charters, the members of the provincial societies thus becoming members of the R. A. I. C.

After discussion, it was agreed to establish an Institute medal of merit to be presented for competition or to distinguished architects. A committee will obtain designs and settle details.

The question of affiliating B. C. architects' Associations was also dealt with.

A roll of honor of men at the front will be prepared, and Mr. A. Chausse, the honorary secretary, was requested to write every society for lists of members who have enlisted.

Real Stone Cheaper Than the Imitation

One of the most illuminating illustrations of the relative cost of different building materials, according to "Stone," is furnished by the bids for the construction of the Madison School, at Syracuse, N.Y. It is worth while to consider these bids which were opened the past month, in detail. The bids in detail were as follows: A, limestone, $217,158; imitation stone, $215,404; terra cotta, $215,851; B, limestone, $227,700; imitation stone and terra cotta, the same; C, limestone, $229,000; imitation stone, $227,000; terra cotta, $225,400; D, limestone, $210,000; imitation stone, $210,967; terra cotta, $215,150. Thus it will be seen that out of twelve separate prices quoted, limestone at $210,000 was the lowest. What is more, this figure is $967 less than the lowest imitation stone bid, and $5,150 less than the lowest terra cotta bid. The most favorable limestone price was no less than $17,700 under the highest imitation stone and terra cotta bids. On the other hand, to put the matter in an absolutely fair light, the highest limestone bid was $18,033 more than the lowest imitation stone, and $13,850 more than the lowest terra cotta bid. What is equally striking is the fact that the bidders who put in high figures for natural stone offered inducements of only a thousand or two dollars in favor of the imitation.

Municipal Engineering Requirements

By A. F. Macallum[*]

PROBABLY there is no branch of engineering that calls for such diversified knowledge as that demanded from the municipal engineer. Certainly he is supposed to have a knowledge of the cost of installing and operating public utilities and executive ability to see that this is at a minimum and comparable with privately owned enterprises. When a city reaches any considerable size it is not possible to follow the details of design and construction of the different works to be carried on and the practical engineering work must then be carried out by special engineers devoting all their time to particular branches while the chief devotes his time to the executive or business work of the department and the policy to be developed as the growth of the city brings forward new problems. It is claimed of municipal engineers that they follow but do not lead in such matters and seldom initiate new policies, but wait until councils and public opinion force them to meet the question. This will be found to be true where the municipal engineer does not keep up his reading and confines himself too much to details.

The railways built in this country some years ago when towns were anxious to secure them, have cut across the cities in a manner to hamper the development of these cities except in certain directions. This is now felt in cities where the future planning for developments is being carried out with a view beyond the present day. But the cost is almost prohibitive in the older built-up sections of a city, to shift the railways, with the result that any report showing a city plan necessitating the spending of millions of dollars, while pretty to look at, is not seriously considered and seldom gets beyond an academic discussion. This is unfortunate, but when it is realized that in this country usually about fifteen mills of a tax rate is from uncontrollable charges it will be seen why aldermen are diffident about increasing it when usually more pressing matters have to be dealt with.

Water Supply and Distribution

Of the different branches of municipal engineering undoubtedly the most necessary is the supply and distribution of water. The city which can get its supply without, in some manner, treating it, is in a fortunate position. The two standard methods of treating used on this continent, one by means of graded sand and usually without the use of chemicals, the other by mechanical methods for the treatment by chemicals, give equally effective results, although the selection of which shall be adopted is governed generally by local conditions.

In New York a very interesting discussion has recently taken place regarding the advisability of filtration outside of chlorination, but because of the diametrically opposite opinions advanced by the engineers of various municipal bodies interested, filtration outside of hypochlorite treatment was decided against, although it was shown that such treatment did not remove bacteria, embedded in particles of suspended matter, decrease turbidity, lessen color or vegetable stain or remove swamp odors or tastes.

The pumping plant in any waterworks system is always of paramount importance. The power used, steam, water, gas or electric, will depend principally upon the operating cost of these motive agencies delivered on the shaft, along with the capital cost of installation, including the size of relative buildings.

With reference to the quantity of water used for usual basis of calculation in America for a new system is 100 gals. per head. Toronto uses 95 and Hamilton 110, while Ottawa, strangely enough, uses over 210 gals. per head, most of which, of course, is waste. Cleveland, on account of waste of water, could not build pumps fast enough until meters were installed, and the consumption dropped fifty per cent. To universally meter the city of Ottawa would cost about $300,000, but the time will come when it will be done in preference to paying excessive power rates for pumping water. We will then have the usual cry that water should be free as air, that people should not be restricted in its use, and all the other time-honored arguments against this waste, which seems to be the heritage of people on this continent.

Sewage Treatment Related to Water Supply

When a town has secured a water supply the necessity for sewers becomes apparent, with (in some provinces) the treatment of this sewage to a more or less vague standard which a committee of this society is now trying to bring to some kind of uniformity throughout the different provinces, but so far with but indifferent success.

Most of the older cities have combined systems, but most of the new places have separate systems. Both have still their advocates, but, with the development of sewage treatments, the separate system has the advantage, especially where the sewage has to be pumped.

The treatment of sewage, becoming necessary as the country builds up, is yet in a state of evolution. The degree of treatment will vary with local conditions, for instance, at Baltimore, it is given a secondary treatment on account of the oyster beds near that city.

The object of present-day methods of sewage disposal has been to take advantage of the oxidation process through the intermediary of living organism. Those that have failed are those that have not supplied these organisms with a sufficient supply of oxygen to carry out their functions. In connection with sewage treatment there are two distinct factors: (a) the removal of all causes which may effect a nuisance, and (b) the removal of all causes which may effect disease.

Most of the standard methods of sewage disposal using screens and sedimentation tanks perform only the functions of clarification to a greater or less extent. By filtering afterwards through slag or stone the nuisance is altogether removed, and if necessary to remove the disease germs the effluent can then be chlorinated.

This, then, seems to be the present-day idea, namely, to remove from the sewage only the chemically organic attributes which create a nuisance by decomposition. No longer do we find the septic tank being built, for, being wrong in principle, it is doomed as an integral essential to any method of sewage disposal.

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[*] Commissioner of Works, Ottawa. Abstract of paper before Ottawa Branch, C. S. C. E.

City Pavements

A visitor to a city may forget its beautiful buildings, but he will never forget its pavements, especially when they are bad. Of the materials in use for pavements may be mentioned granite and sandstone blocks, wood blocks, asphalt blocks, brick, sheet asphalt, asphalt concrete and concrete. Of these materials the stone and wood blocks are used for the heaviest traffic, asphalt brick and asphalt concrete on medium, and concrete on light. In this country, except in limited areas on heavy grades combined with heavy traffic, granite blocks are not necessary, and are seldom used on account of the high cost of construction and excessive noise unless well laid. Treated wood block in increasing amount is being laid as meeting most of the requirements, besides being quiet on heavy traffic streets.

On street car streets most municipal engineers favor the lip girder rail, and all street railway engineers favor the tee rail, one side because the possibility of grooves cut alongside the rail is limited, and the other because of the longer life of the rails. The pavement to be laid between and alongside the rails is limited to stone block, wood block, and brick. A few places have laid the asphalt right up to the rail, notably New York, where very heavy rail sections are used, but usually it is not a success. The tracks should, of course, be rigid, for no pavement will stand up alongside a track that moves under car operation. The spaces alongside the web of the rail should also be carefully filled to prevent as much as possible the access of water to the base of the blocks.

Sidewalks Cause Controversy

On sidewalks there is comparatively little to say, although there is more friction with citizens in outlying districts over sidewalks than all other improvements combined, especially where the surface is of a rolling nature. The average citizen seems to believe that the grade of the sidewalk should be the same as the front of his lot, and that if there be a cut or fill opposite his lot then someone has blundered in the city engineer's department.

House Numbering and Street Signs

House numbering, street signs and street lights are important municipal subjects. The numbering of houses is a municipal function which too often does not receive the attention it merits from officials, judging from the inconvenience suffered by both citizens, strangers and the postal system. A city laid out irregularly will require a somewhat different treatment from one on the rectangular plan. Probably the most common and simplest way is to begin numbering the houses on any given street at one end of that street and continuing the numbers in succession toward the other end, allowing a number to each unit of a uniform number of feet, such as 25, the odd numbers on, say, the north and west sides. The numbers should be of such a nature that a person can readily see them.

Street signs should be at each street intersection and on each corner of the intersection if they are to afford the greatest convenience. They should be plainly visible from street cars and sidewalks, both by day and night. In Hamilton the signs are so placed on electric light posts that the light shines on them. These signs are strongly made of iron, enamelled with blue back ground and white block letters.

In the lighting of streets it is desired to get as nearly as possible uniform illumination over the entire area of the street. The aim generally is to insure that the illumination at no point will be less than a given minimum and by means of refractors as nearly uniform as possible.

The City's Cleanliness

The keeping of the streets in a clean condition comes directly under the municipal engineer until such time as the city arrives at a population of several hundred thousand, when usually a separate department is created that includes also the collection of the city wastes.

The collection and disposal of city waste is a question that must be decided at some time as a town grows, and each city must work out its system for collection and method of disposal. If collections of city refuse be made from the curb the cost of collection will be about one-half the cost of collection from the rear of lots or buildings. By refuse I include rubbish, garbage and ashes, which vary in each city, and also in different districts of a city, the poorest districts having the least amount of garbage and ashes.

The disposal of the city refuse is generally by dumping and filling in low places around a city, with more or less nuisance if close to residences. Cities of over a hundred and fifty thousand can operate reduction plants and pay operating costs. In some of the cities both reduction and incinerator plants are in operation.

Incinerators are better for smaller cities, but it should be remembered that these plants, while they will operate satisfactorily under definite physical conditions, if these conditions be altered they will not operate satisfactorily. For this reason, of 280 incinerators built from 1885 to 1908, 102 have been abandoned or dismantled. However, for the smaller cities they are about the only plants to be installed when the dumping places have been filled.

The above outlines but the work in the more important departments to be covered in municipal engineering and does not touch the smaller and often more troublesome matters that crop up and are always sent on to the man who is supposed to know it all—the municipal engineer.

One-Third of Members of Calgary C.S.C.E. at War

THE Calgary branch of the Canadian Society of Civil Engineers has 33 per cent. of its membership enrolled in the overseas army. Some of these have paid the great price. On April 25 Lieut. Col. J. S. Dennis, president of the Canadian Society of Civil Engineers, unveiled a roll of honor at a dinner at the Palliser Hotel. Prior to unveiling the roll Col. Dennis referred at length to the great work done by the members of the profession in the world war, instancing the submarine, aeroplane, and zeppelin as products of the profession. He stated that the engineering branches of the army deserved the greatest possible credit. They had taken just as great risk, had suffered as great losses, and were just as necessary as any other branch of the army. Many engineers had been decorated and received special mention, and he was proud to be president of such a body.

Perhaps the greatest work that the engineers could be called upon to perform would come after the war, when they would have to help in the re-habilitation of several countries. This work would call for great energy. The Russian Government alone contemplated building 12,000 miles of railway, and would also build up a vast steel industry as soon as this could be done. The country had the natural deposits of ore and coal, and following the war there would be a great demand for engineering research and development. In the matter of chemical research the engineers had performed wonders. They had tackled and solved problems that before the war had been considered unsolvable. Many of the engineers had not been privileged to go overseas, and these after the war would probably be called upon to help restore the countries. They should be willing to give freely of their ability to help solve after-the-war problems.

The following were the names on the honor roll: J. H. Rosher, lance-corporal, Princess Pats, killed in action; Lieut. C. F. D. Ross, divisional engineers, killed in action; Lieut. E. B. McLean, missing since November, 1916; S. R. Lamb, J. H. Jones, R. L. H. Gooday, J. A. Symes, G. R. Elliott, F. R. Burfield, H. R. Carscallen, G. H. Whyte, Paul Weatherbee, P. J. Jennings, F. S. Dyke, H. B. Muckelston, F. K. Beech, V. Meek, T. M. Montague and J. E. Caughey. The roll of honor was the work of Mr. N. A. Pearson, one of the members of the branch.

Two Montreal Schools

MR. C. A. Reeves, architect, Montreal, has designed two schools, to be erected on Pius IX. Boulevard, Maisonneuve, for the Roman Catholic School Commissioners. The schools, one for boys and the other for girls, are to be on a site 250 x 600 feet, and will be separated by about 200 feet. They are similar in design and accommodation, the only material difference being that the girls' school includes a residence for the nuns. The area of the girls' school is 215 x 75, and that of the boys' 169 x 75. Both are three storeys high.

The foundations are to be of concrete, and the exterior of stone up to the first floor and of Kittanning brick, backed by common brick for the front elevation of the other storeys. The structures will be carried on steel frames. The floors will be of birch over reinforced concrete. The interior walls and the ceilings will be of Rocalite plaster, while the class rooms are to be divided by terra cotta partitions. The stairs and railings will be of architectural iron. Barrett specification for the roofs is included in the contracts. All the interior wood fittings are to be of chestnut finish. The lavatories, which will be provided on all the floors, will have white tile floors and walls. Fire escapes are to be provided.

Each school will have three entrances at the front, with the main entry in the centre, and a similar number at the rear, the latter leading to extensive playgrounds. The first floors will be devoted to assembly halls, and will be fitted with stages. The remaining floors will each contain seven class rooms, 26 x 30, with the necessary cloak rooms. On the ground floor there will be an office for the public, and on the other floors, rooms will be set apart for the teachers' use.

A boiler house of brick is to be constructed about 150 feet distant from the school. This will contain two boilers for supplying the hot water heating and also fans for the forced air ventilation system. The hot water and air wil be conveyed through pipes to the schools. The lighting will be by electric light, all the piping being laid in iron conduits.

Mr. A. Choquette, Montreal, has the general contract for the girls' school, and tenders have been received for the boys' school.

Principles for Design of Retaining Walls

The following principles to be observed in the design and construction of retaining walls were recommended in a report of a committee of the American Railway Engineering Association:

(1) For usual conditions of the filling use an angle of repose of 1½ to 1. For dry sand or similar material a slope of 1 to 1 may be used.

(2) The maximum pressure at the toe of the retaining wall should never exceed the safe bearing pressure on the material considered.

(3) When the retaining wall rests on a compressible material, where settlement may be expected, the resultant thrust, E, should strike at the middle or back of the middle of the base of the wall so that the wall will settle toward the filling.

(4) When the retaining wall rests on a material where settlement may not be expected the resultant thrust, E, should not strike outside the middle third of the base, except as noted in (5) below.

(5) Where the retaining wall rests on solid rock or is carried on piles, the resultant thrust, E, may strike slightly outside the middle third, provided the wall is safe against overturning, and also provided the maximum allowable pressure is not exceeded.

(6) In order that the retaining wall may be safe against sliding, the frictional resistance of the base, combined with the abutting resistance of the earth in front of the wall, must be greater than the horizontal thrust on the back of the wall.

(7) The filling back of the wall should be carefully drained so that the wall may not be subjected to hydraulic pressure.

(8) The foundation for a retaining wall should always be placed below frost line.

(9) A careful study should be made of the conditions in the design of each wall, and it should be remembered that no theoretical formula can be more than an aid to the judgment of the experienced designer. The main value of theoretical formulas is in obtaining economical proportions, in obtaining a proper distribution of the stresses, and in making experience already gained more valuable.

The Montreal Board of Control have awarded the contract for the construction of the Lasalle bridge to Mr. A. Pion. The contract was originally given to Mr. T. O'Sullivan, who, after executing a portion of the work, declined to proceed, on the ground that it was impossible to fill it on account of the increase in the cost of materials. The new contract is at an advance of $58,000.

The council of the Canadian Society of Civil Engineers at Montreal has approved the change in name of the Regina Branch to the "Saskatchewan Branch" of the Society.

Modern Road-making Machinery—Its Selection, Use and Care

By W. Huber, A.M. Can. Soc. C.E.*

A discussion of modern road-building machinery resolves itself into a discussion of road-building itself, for very few operations in the construction of our highways, especially where the work is on an extensive scale, are carried on without the aid of machinery of one kind or another. The measure of success achieved and the economies effected through this extensive use of machinery will depend principally on three things: intelligent selection, competent operation and careful maintenance.

Road construction is carried on under widely varying conditions, and the selection of machinery for any operation involves a careful study of these conditions. The capacity of the machines to be purchased, the power required, the most desirable weights for rollers, etc., should be carefully determined in advance. Equipment once used and found unsuitable cannot be sold or exchanged except at a heavy discount, and it therefore behooves the purchaser to make no initial mistakes.

The Human Factor

The progress of the work and the interests of the machinery itself demand the very best class of operators. No machine is endowed with human intelligence, nor is any road-making machine automatic in action. Success depends on human guidance and control, the efficiency of which is reflected in the results. While the various operations included in the construction of county roads may be classed as rough work, they require much skill and intelligence of a certain kind, and the lack of these two great essentials is sufficient to prevent results otherwise obtainable with even the best equipment.

Nearly all machinery begins to deteriorate as soon as it begins to work, and this is especially true of road-making machinery. Working amid dust and dirt, exposed to all kinds of weather, and subjected to rough handling, the depreciation is great. Unless such machinery is carefully maintained, its capacity will be reduced, while at the same time the cost of operation will be increased, the result being lower efficiency, higher costs and less satisfactory work.

The ordinary operations in the construction of county roads are grading, quarrying, crushing, hauling, rolling and watering. Each of these operations is now performed by up-to-date machinery as against more or less primitive methods formerly in use. In view of the fact that these several operations are now carried on almost entirely by the use of machinery, it is readily seen that efficiency in road construction may be greatly increased through the careful choosing of machines and their operation in such a manner as to produce the best results.

The first machine used in road construction is usually the grader. Grading machines are manufactured in different sizes and weights, and choice will depend largely on the conditions under which such a machine is to be used. Wherever possible the tractive power should be furnished by a mechanical tractor. Operating costs of a steam or motor tractor are approximately equal to the wages of two teams, while the work accomplished is from 25 to 50 per cent. greater.

Co-operation of Crusher and Roller

Where roads are built of local stone, the usual practice is to place the material on the road directly after crushing. The crusher and roller are thus expected to work together, the roller consolidating the stone as it is brought from the crusher. Efficiency demands that the stone be rolled and finished immediately after being placed on the road. If left only half-rolled, it is certain to be disturbed by traffic, and much of the roller's work is undone. The spreading and partial rolling of long stretches of stone is the cause of much unnecessary expense. Economical practice also requires that both crusher and roller be working to capacity, but that the roller is not rushed to such an extent as to encourage inferior or half-finished work Exactly as much stone must be furnished the roller as it can properly consolidate, and no more.

A common source of loss in crushing road material is the attempt to operate a crusher with too limited a capacity. The daily output of crushers with jaw openings less than 9 in. x 16 in. or 10 in. x 18 in. has been found too limited to satisfactorily supply the average roadmaking outfit, and the smaller machines should not be considered. Similarly the motive power should be sufficient to drive the machine at full speed under a full load. The time lost in a day's run due to slowing down when the load becomes heavy amounts to a considerable total. For lowest crushing costs the crusher must be worked to its capacity. This is accomplished only by keeping the jaws full and by rejecting all stone too large to properly enter the jaws. For maximum output the crusher should be blocked up off its wheels, which precaution reduces the vibration and prevents unnecessary wear on the axles and subsequent heavy draught on the road.

Working Parts Well Lubricated

In the interests of the crusher itself, special attention should be given to lubrication. The conditions under which such a machine works are severe enough without its having to suffer from lack of oil. Owing to the dust, automatic oiling devices have not, in general, been found reliable, and good lubrication is better assured by the frequent application of small quantities from an ordinary oil can. Even with the best of care, the wear on crusher bearings is very rapid, and in the selection of an outfit a point worth considering is the ease with which bearings and other wearing parts may be replaced.

The selection of screens for separating the various sizes of crushed stone is important. For road work two screens, furnishing three sizes are advisable, the sizes of the perforations depending on the character of the stone. When limestone is being crushed the perforations giving best results are 3-inch and 1¼ inch or 1½ inch. For use with granite or trap rock, the perforations should be rather smaller, 2½ inch and 1 inch holes having been found most satisfactory. A bad practice occasionally observed is that of using three screens having approximately 3-inch, 1½-inch and ¾-inch perforations. This arrangement gives four sizes of stone, including a size ¾ inch to 1½ inch, which when used by itself is more detrimental than useful.

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* Assistant Engineer, Ontario Department of Public Highways. Abstract of paper before Canadian and International Good Roads Congress.

The Selection of a Roller is Important

The stone having been placed on the road, the next, and in many respects, the most important operation, is that of rolling. The intelligent selection of a roller requires the careful consideration of a number of points. First, the weight must be decided on, and will be governed principally by the subgrade on which it is going to work. Motor-driven rollers having in recent years come into prominence, the choice between steam and gasoline or kerosene may well be considered. Owing to its longer and wider use, steam is more generally understood, and it has heretofore been easier to find operators who understand steam engines than those conversant with gasoline motors. This condition is rapidly changing, and with the greater simplicity and increasing reliability of gasoline engines, together with the greater number of men who really understand them, the motor roller is rapidly gaining in favor; and further, it has a number of advantages over the steam roller.

The greatest wear on a roller is seen on the rear rolls, which soon become rounded. When this occurs consolidation is slower and not so well done. With rear wheels having detachable rims such as are supplied on certain rollers, the cost of renewing the rims is much smaller than where the entire wheel must be purchased.

The Governing Factor in the Organization

The roller is, or should be, the limiting factor of the organization, and as it is the most expensive part of the outfit, it should be worked to capacity. It is a comparatively easy matter to suit the other operations, —quarrying, crushing, hauling, grading, etc., to the capacity of the roller. For this reason it will pay to secure the most capable operator obtainable. His duties are twofold, to obtain the greatest amount of effective work from the roller, and to keep it in a condition of maximum efficiency. Having secured such a man it is advisable to hold him at almost any cost, for the savings he can effect will amount to many times his wages.

The principle on which all rolling should be done is that of securing the utmost consolidation with the least work. It must be so performed that each passage of the roller accomplishes something in the final consolidation of the stone. For efficient consolidation the stone must be rolled and finished as soon as possible after it is delivered to the road. Furthermore, satisfactory consolidation can be secured only when the stone is confined at the sides. Unless a shoulder of some kind is furnished to keep the stone within the required width the weight of the roller on top will cause it to spread and form a thin edge which is easily broken off, at the same time destroying the crown of the finished road.

Continuous Operation Essential

The efficiency and economy of rolling depends on continuous operation, and anything which tends to retard the roller destroys its efficiency and raises the cost. Frequently a serious retarding influence is lack of water for finishing. Delays due to this cause may be prevented by the employment of two tanks in order that there may always be a full tank on the job. Considering the delays which may be caused by lack of water, the cost of operating an extra tank is negligible. Hand pumping which was always laborious, particularly in hot weather, is now replaced in up-to-date outfits by a pump driven by a small gasoline engine mounted on the tank.

Mechanical Haulage Costs Less

A large part of the work and expense of road building lies in the transportation of materials. Frequently stone and gravel must be hauled long distances over roads which are none too good, and any considerable saving which can be effected in haulage costs will materially reduce the cost of the finished road.

As a means of moving large quantities of material, team haulage is fast losing its importance. The increasing wages of teams and men have made this method, always woefully inefficient, almost prohibitive, and it is being replaced by mechanical traction. The cost of team haulage is usually between 20 cents and 40 cents per yard-mile with an average on country roads of from 25 to 30 cents. Under very favorable conditions traction haulage has been accomplished for less than 5 cents per yard-mile, while a fair average would probably be 8 cents to 12 cents. With such a difference in unit costs for the transportation of material it is a source of wonder that teams are still used to such a great extent.

Low traction haulage costs are dependent on the selection of machinery most suited to the exact conditions under which the work is to be done, to the careful operation of the machinery, and on the organization and planning of the work in such a way as to eliminate all delays. If these conditions are complied with, there is no doubt as to the economy of traction haulage. Otherwise through the employment of unsuitable equipment, delays caused by breakdowns, and intermittent or interrupted work, the cost may equal or exceed that of well-directed team haulage.

Equipment Must Not Be Too Heavy

A common mistake in the purchase of hauling machinery is that of selecting equipment which is too large and heavy. Better results can usually be obtained from reducing the size of the car and increasing the number. One advantage attending the use of smaller cars is that where a steep hill on a route compels a slight reduction of the load it may be accomplished by the dropping of a single car. If two or three large cars are used the dropping of one car means the reduction of the load by a much larger percentage than when only one of a larger number of small cars is removed. Nothing but reversible cars should be used, otherwise the train may be compelled to travel a considerable distance along the road to reach a suitable turning place.

The reduction of lost time being an important consideration, a hauling outfit must be loaded in the shortest possible time. Many loading devices are in use, varying with the source of the material and other conditions, each designed to reduce the time during which the hauling machinery is standing idle. If loading cannot be done without loss of time it is necessary to have two trains of cars in order that the tractor may be kept moving.

The motor truck has very recently come to the front as an important factor in the transportation of materials. Where hauling is to be done entirely over roads of the best class, the selection of this form of haulage may well be given consideration.

Maintenance Suggestions

The entrusting of general care and repairs to the operator of each machine is inefficient, extravagant and dangerous. Operators are changed frequently, and many of them go to one or other of the two extremes of wanton neglect of their machine or a desire to be continually "tinkering" with it, either of which is bad for the machine and bad for the work. "Everybody's machine is nobody's machine," and continuous and efficient operation of equipment can be assured only where responsibility for the condition of the entire outfit is centered in a capable master-mechanic. His duties should include frequent personal inspections of each machine, both in operation and at rest, the acquiring and storing of a reasonable stock of repair parts likely to be needed, and the supervision of all repair work.

Care of machinery during periods of idleness is almost, if not quite, as important as its care during operation. A few months exposure to the elements, or to conditions promoting rust, will cause greater depreciation than a whole season's legitimate use. Careful attention to its protection at such times should result in longer life and smaller repair bills.

Before leaving for the winter or for any long period, all wearing surfaces and parts liable to rust should be well protected with oil, and all machinery should be laid up with a view to making the work of refitting as easy as possible. During the winter such repairing and refitting as must be done in a machine shop should be carried on, in order to lessen the rush at the commencement of the following season.

Summing up, modern road-making requires modern machinery. In order that it may give best returns for its cost it must be exactly suited to the work it is doing, it must be operated by competent men who know how to get results from it, it must be operated without loss of time, and it must be kept under experienced supervision and carefully maintained. Failure of any equipment to accomplish all that is expected of it may usually be traced to the violation of one or more of these rules.

Comparison of Structural Materials

THE following comparisons of the adaptability of the various types of masonry were presented in an address by Horace R. Thayer, of the Carnegie Institute of Technology, at the Engineers' Society of Western Pennsylvania:

Stonework is being limited more and more to cases where appearance is a vital factor. Even here various methods of treating concrete are being developed which are lessening the former objection to its rough and monotonous exterior. Furthermore, concrete is cheaper for a given strength, and is fire-resisting, while stone is not.

Brickwork still continues to hold its own for thin walls, where the stresses are light and a good appearance is demanded at a minimum cost. It is a first-class fire-resisting material, but is ill adapted to resisting earthquake shocks.

Concrete is an excellent material. It is strong and in general durable and fire-resisting, but quite brittle. Reinforced concrete has all the advantages of the plain variety without the last-named disadvantage. The plain material is best for walls and foundations, where its large bulk and weight are not objectionable. At equal costs, it is always better to carry a load by a weight than by a stress, for the consequences of minor faults may be much more serious in the latter case. Reinforced concrete is the proper material for arches, culverts, bridges of short span, and buildings of low or medium height.

Timber should be employed for temporary structures exposed to the weather where the duration is not expected to exceed ten to twenty years, or where extensive alterations may be expected in that time. For a building these limits may be somewhat extended. The above advice presupposes, however, that there is no extensive conflagration hazard. While timber may be made as safe a fire risk as steel in many locations, it is more dangerous to the structure alongside.

Steel will be recognized as one of the principal competitors of reinforced concrete. The advantage of the latter is its durability. On the other hand, we might protect the steel, in which case we are likely to find it somewhat higher in cost. The writer, however, prefers the steel in many instances, because he feels that it possesses far more security, due to less liberal assumptions and greater ease of repair or alterations.

Determination of Weight per Cubic Foot of Sand

AT the last annual meeting of the American Concrete Institute the Committee on Aggregates reported the results of experiments performed for the purpose of ascertaining the method and apparatus by which the most reliable results in the determination of the weight per cubic foot of sand by different operators under different conditions may be obtained. This work was carried out by a joint committee of the American Society for Testing Materials and the American Concrete Institute. The conclusions are here reproduced:

Remembering that the variables which need to be standardized are (1) the size and shape of the measure (2) the method of filling the measure, and (3) the amount of moisture in the sand, experiments were made at seven different laboratories on sand of two grades—one coarse, the other fine. With wet sand a much greater range in average weight, average maximum variation and mean variation was obtained. Because of this great range, the conclusions presented in the discussion are based wholly on the results for dry sand.

Seven different methods of filling the measures were tried, namely: A, filled and struck; B, filled and jarred; C, jarred while filling; D, tamped in layers; E, filled and tamped; F, filled through funnel; G, inner tube, and a cone method used in one laboratory only. The lower weights were obtained by methods A, F, and G, while the higher weights resulted from methods C, D, and the cone. The cone method showed least total variation, with methods D and G as second choice, while for mean variation the cone method was lowest, with methods F and D as second and third.

Effect of Size of Measure

The results for size and shape of measure show slightly higher values for larger cylindrical measures than smaller ones, while the cubical measures of ¼ cubic foot capacity gave a somewhat lower result, probably due to failure of the sand to pack as closely in the corners. The differences are small, however, and may not influence the choice of size, except to show that one size and shape should be adopted as standard. The cone measure, due chiefly to the method of compacting and filling, gives very much higher weights—so high, in fact, as to bear little relation to the weight per cubic foot of sand in any condition which would be found in practice. The mean variation shows that, size for size, the round measures are more concordant than the square measures.

Before a definite choice can be made of both method and container it will be desirable to conduct further investigations to ascertain the degree of compactness of sand in the various conditions in which it exists on the job and in concrete and mortar. Such investigations are in progress, and a choice of method and measure will be recommended for adoption when more complete data are gathered.

Preferable Methods of Grade Crossing Elimination

FOUR main forms of grade-crossing elimination—by elevating the tracks, by depressing the tracks, by elevating the streets and by depressing the streets—were discussed at considerable length in the report of the Roadway Committee of the American Railway Engineering Association, presented at the recent convention, and which is reviewed in Engineering News-Record. The most obvious conclusion reached by the committee is that with a small number of streets the track profile should, if possible, be left undisturbed, while with numerous built-up crossings the railroad grade must usually be changed. The committee suggests track elevation for industrial districts and track depression for residential districts. It also points out the frequent possibility of having streets vacated, and lateral streets substituted for crossings. In general, the committee notes that each case should be settled on its merits, but its presentation of the relative advantages and disadvantages of these four types and combinations of them may be helpful in making the choice.

Factors in Grade Separation

As salient points in making a grade-separation study, the committee cites physical conditions, embracing sub-soil, water and drainage, and material (including consideration of the questions of excavation, haul, borrow and disposal); railway operation, embracing motive power, character of traffic and volume of traffic; grades and alignment, sub-headed as railways, streets and abutting property; right-of-way, embracing present and future development, width and value; the district, whether residential, commercial or industrial; and lastly public utilities, sub-headed as improvements, interference and damage. For residential districts the questions of value, improvements and damages would govern. In commercial districts value, present and future traffic, track connections and expansion must be considered, and the same features present themselves in industrial districts.

As between full track elevation and full track depression, it is pointed out that, because of the difference in the required clearances, track elevation changes the grade from 16 to 18 ft., while depression changes it from 24 to 28 ft. This difference will materially affect the grades and the cost.

Drainage is sometimes difficult, in both track depressions and street subways. Pumping, which has to be resorted to when the cut is too deep for direct drainage, is expensive in operation and liable to accident. As sewers are usually fairly deep, however, and the clearance for street subways may often be reduced to only 12 ft., it is more probable that direct drainage can be obtained for subways than for track-depression cuts.

Changes in Underground Facilities

Track depressions frequently require elaborate changes in underground facilities, all of which are usually avoided when the tracks are elevated. To avoid disturbance of such facilities, partial track depression is sometimes advisable in districts not too much built up. While this necessitates raising the grade of the cross-streets approaching the cut and may entail damages for buildings, it avoids siphoning sewers, reduces excavation and retaining walls and utilizes the spoil in grading up the street. By this means, too, the tracks in the cut are brought to a convenient level for serving the basements of adjoining buildings.

Partial elevation will bring the level of the tracks to a convenient height for delivering goods to the second floor of adjoining buildings. Here, too, the spoil from the subway excavation may be used in the railway fill and reduce the amount of haul and borrow.

For service to adjoining industries a fully elevated line may have an advantage over a fully depressed one. A building may be more readily adapted to elevated connection without extraordinary expense. It is also usually easier to maintain operating connections with industries while tracks are being elevated than while they are being depressed.

Comparative Grading

For equal depths track depression usually requires more width of roadbed, on account of the necessary ditches. If the full right-of-way is occupied, track depression might call for the abandonment of one of the tracks or the purchase of additional lands.

Under the same conditions more material will usually have to be moved for track depression than for track elevation, and at a higher unit price. On the other hand, the cost of land for borrow pits, the length of haul and the interference with regular traffic in the case of track elevation, considered with the value of low land that may be reclaimed by dumping spoil in the case of track depression, may throw the balance in favor of the latter.

Ordinarily, the difference in cost of bridges would be slight, but may be in favor of track depression, as elevated bridges come under more general observation and call for more artistic treatment. Objections comparable to supports in roadways are not encountered in track depression, except where yards are to be crossed, where it may be necessary to rearrange or abandon tracks to accommodate the required supports.

Public annoyance from smoke and gases will be less, especially at street crossings, with elevated than with depressed tracks. On the other hand, in the matter of noise the cut is preferable. Hence, where tracks are electrically operated, depressed tracks may have the advantage, especially as they afford the opportunity to utilize the "aerial" rights, as at Grand Central Terminal, New York.

Construction Difficulties

Tracks cannot be raised piecemeal under traffic in a city without closing cross-streets, unless the traffic may be temporarily carried on narrow crossings by elevating them with the tracks. This, however, is extremely expensive and may call for abnormal grades.

With single tracks, practically the only way is to make a temporary detour. With double tracks, the tracks may be gantleted, or all traffic turned to one track, operated in both directions. Trestling is usually necessary for a fill, often heavy enough to carry the regular traffic; and where the traffic is sufficiently dense to preclude work trains operating on the same track, a second dumping trestle may have to be built.

Where partial elevation or depression is adopted, the cross-streets must be treated one-half at a time, the change of traffic to the new grades being made simultaneously both on the railway and on the street. When the municipality is participating in the expense, it will usually close as many streets as possible during construction.

Conclusions

These four definite conclusions were reached by the committee and were adopted by the association:

1. Whenever grade separation through densely built-up thoroughfares (short blocks, say from 12 to 15 crossings per mile) becomes imperative, elaborate studies of the kind and volume of traffic on each thoroughfare should be made and due records kept with a view to eliminating or vacating certain of these crossings as wholly unjustifiable from a cost standpoint, and opening lateral streets at a less cost in their stead.
2. If only a few crossings are to be eliminated in an industrial district, with reasonable assurance that no others will be required, the methods used, other things being equal, should not disturb the tracks.
3. If several crossings are to be eliminated in an industrial district, the most efficient method, other things being equal, is by track elevation.
4. In a residential district, if grades and other conditions on the railway will permit, complete depression, allowing the streets to remain at their original level or nearly so, is the preferable method.

To Make a New Surface Stick to an Old Concrete Floor

The process of applying a new surface on an old concrete floor is usually attended with indifferent success, inasmuch as the new top will rarely stick to the old base, and cracking, peeling, asd crumbling results. Much discussion has centered around the proper method of performing this operation successfully. In the following article, written by A. K. Siebrandt in "Concrete," a method of overcoming this difficulty is described:

From my own experience, it is evident that a new top will not stick on a concrete base that is four and five years old, because of the different action of the two masses. The old concrete has hardly any action whatever. Its shrinkage and expansion are so slight they are of little consequence, whereas the new top must go through its process of setting, which, of course, causes some shrinkage, and consequently it breaks away from the old concrete, or, if it adheres to the base, cracks will appear.

Two years ago I put a new top on some old floors. The old surface was made of "composition," and had all come up and crumbled away. Knowing of the difficulty of making a new top stick to an old concrete base, I took particular pains in putting the mortar down. I chiseled off all the old surface, then gave the concrete a good scrubbing and kept it continually wet, as there were four steam pipes running through the 8 ft. x 12 ft. room; also heat from the room below, which kept the floor always warm. Next morning I again wetted the concrete thoroughly, then scattered neat cement over it, took a broom and swept the cement all over the floor so that cement paste covered all the old concrete. Then I proceeded to put on the top (1:2). I took care that the old concrete was always wet.

In putting down the top I had it at a jelly-like consistency, so that it worked easily, and before I rodded it off I worked a thin layer like plaster, putting on lots of elbow-grease, so that all the holes and cracks in the old concrete would be filled with mortar; then I went over with the rodding stick three or four times, with a zigzag motion. In finishing it I gave it four floatings, then trowelled it to a glass finish. It was a splendid piece of floor, and I was well pleased with the work, thinking, of course, that I had succeeded in putting a new top on an old floor without having it crack.

My joy was of short duration. As spring came and the heat was turned off from the buildings and the temperature changed, the floor cracked badly.

This winter a large slab of the composition floor was torn up in two large dormitories. Again I had to make repairs with concrete.

How the Second Floor Was Laid

I chiseled some of the old concrete off, so that I would not put less than ¾ in. of top on; then stretched a wire netting (chicken fence wire), and fastened it to the concrete, and proceeded as before, giving the floor a good wetting and sweeping a neat cement grout over it and trowelling some of the mortar in. As soon as it was ready to finish I laid it off in blocks 25 in. square and cut the top with my pointer clear down to the old concrete, just as I would have jointed it off with the jointer; but I didn't use the jointer. Then I trowelled over the cuts. As the floor was finished there were no cuts to be seen. Two days after very fine hair joints appeared where I had cut the top; they could hardly be seen except by stooping down and looking for them. No other cracks have appeared, except in the corner where the steam pipes were and where the top had dried too quickly and a few heat cracks appeared. Otherwise the floor is sound and solid.

I have never before seen this method suggested. There are floors laid with joints, but they have objections, whereas the hair joints that I made leave the floor smooth and level and are quickly and easily made.

Major Cape Wounded

Major E. G. M. Cape, it is reported, was wounded in the recent heavy fighting following the battle of Arras. The most definite information is that he is on sick leave in London. Major Cape, who is president of E. G. M. Cape, Limited, contractors, Montreal, raised one of the first units that left Montreal, which was known as Cape's Battery, Heavy Artillery.

The idea of employing alligators in the cleaning of sewers has been adopted in Jacksonville, Fla., and it is now proposed to use the same plan in the city of Trenton. The way in which the operation is carried out is to place the alligator in the sewer, tying a rope to its body, and let it crawl through the sewer. Chains are attached to this rope and these are pulled back and forth by man power to clear away the obstruction.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Integral Curb Construction

CONCRETE is the only paving material which permits economical construction of curb and gutter really a part of the pavement itself. The name "integral curb" has been given to such construction. In general there are two distinct types of integral crub. The illustrations of these types, with the following recommendations, are those of the Portland Cement Association. Each can be varied in form to best conform to the requirements of the particular street or road pavement of which it is to be a part. The integral curb with slightly battered face, shown in Fig. 1, is not unlike, in section and perspective, the familiar unit type of curb. Its use is indicated where the straight type of unit curb would otherwise be selected.

The other type of integral curb, shown in Fig. 2, is more in harmony with requirements of park drives

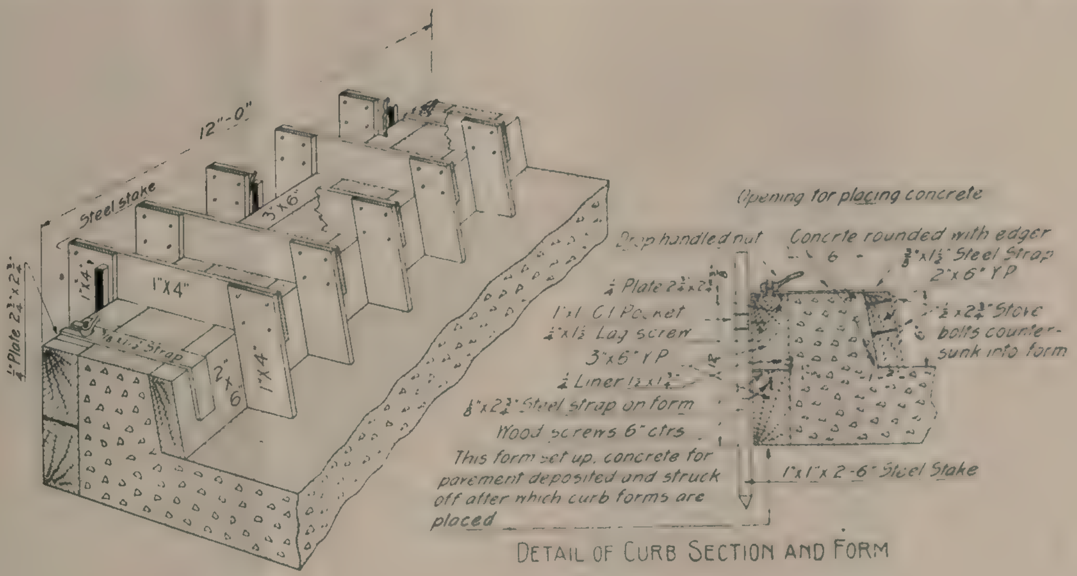
12"-0"
Steel stake
3"x6"
1"X4"
1"x4"
¼" Plate 2¼"x2¼"
Strap
2"x6"
1"x4"
Opening for placing concrete
Drop handled nut
Concrete rounded with edger
6"
⅜"x1½" Steel Strap
2"x6" YP
¼" Plate 2¼"x2¼"
1"x1" CI Pocket
¼"x1½" Lag screw
3"x6" YP
¼" Liner 1½"x1¼"
⅛"x2¾" Steel strap on form
Wood screws 6" ctrs
½"x2¼" Stove bolts counter-sunk into form
This form set up, concrete for pavement deposited and struck off after which curb forms are placed
1"x1"x 2'-6" Steel Stake
DETAIL OF CURB SECTION AND FORM

Fig. 1

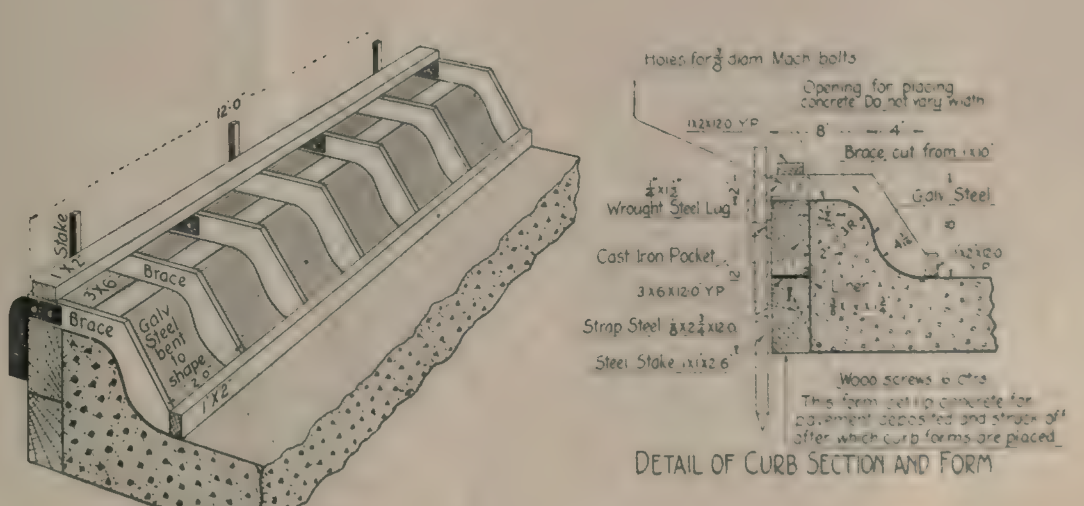

Fig. 2

Two types of forms for integral curbs.

or parkway pavements in residential sections where the paved areas are often made a minimum width and the parkways made wide, and has a face corresponding to a reversed curve.

The inside form for this modification of the integral curb is faced with galvanized iron and held in place by means of wooden cleats cut to the required contour of the face. The general principle of this design may be adapted to a variety of curb shapes which will readily suggest themselves.

The width and height of the curb or the depth of the gutter when built integral with the pavement depends on the amount of water that must be conducted to inlets. On any paved street the height of curb should at least be equal to the crown height, with a minimum of three inches for pavements, say 18 feet wide, and a maximum of eight inches for very wide pavements. The width or integral curb should never be less than five inches nor more than eight inches.

Construction details are essentially the same for both of the types illustrated. Side forms for the concrete pavement are staked to line and grade, concrete deposited and struck off with a strikeboard which travels or is guided on the side form. As soon as concrete has been deposited and struck off for a sufficient distance ahead so as not to interfere with a length of curb forms, the upper half of the back form board and the form for the curb face are placed in position. Both front and back forms should be carefully aligned, otherwise the final appearance will be unsightly. The form board for the face is prevented from springing out of line by clamping back and face forms together with wood cleats, spaced about two feet apart.

When curb forms have been securely fixed to line, "quaky" concrete is placed and well spaded along form faces to insure a smooth, dense surface. For economical construction this concrete is proportioned the same as that in the street pavement. Where the pavement is two-course work, however, the curb is made of the mixture used for the pavement wearing course.

Concrete for the curb should be deposited within fifteen minutes after striking off the concrete pavement. In spading concrete in the curb forms, the tool used should be worked deep enough in the concrete to make certain that the concrete of the pavement and of the curb will become truly a part of each other. After striking off the excess concrete in the curb form, the work is allowed to remain undisturbed until the top can be finished. As soon as the concrete has hardened sufficiently, the face form is removed and finishing completed.

If there is a little rise and fall in the gutter, drainage can be improved by steel troweling the pavement surface for a distance of 18 inches out from the curb line. Excessive use of the steel trowel should be avoided.

In integral curb work a so-called dry concrete mixture should be avoided. The concrete should be of the same consistency and mix as used for the street pavement, proper, to prevent liability of spalling and cracking.

Joints in the curb are made where joints in the pavement slabs occur, thus making pavement joints continuous through the curb. It is important that there be a complete separation, and that the joint in the curb between adjacent sections is at least as wide as the joint in the pavement. To insure this there should be used at least two thicknesses of ¼-inch joint filler or a ½-inch steel separator which can later be withdrawn and the joint filled with tar. To make certain that there is a full ½ inch between adjacent sections of curb, an edger should be run along each side of the curb joint filler or steel separator. The separation should be made complete from back to front and from bottom to top of curb.

Paint Protection of Steel and Iron

PAINTING of exposed iron work is a method that aims to prevent rust deterioration by excluding the moisture that is essential for the production of rust. Paints for this purpose usually consist of an oil vehicle and a pigment. The lead pigments, notably the red lead and blue lead, are particularly high-grade materials, since the process of manufacture insures a minimum of dangerous ingredients. Their usual fineness permits intimate mixing with oils so as to form an integral and homogeneous part of the paint film. Other pigments act in a more or less heterogeneous manner, and do not thoroughly mingle with the oil vehicle. Zinc oxide, although frequently used as a pigment, is sometimes unsatisfactory, in that, owing to its liability to form zinc carbonate, which has twice the volume of zinc oxide, it causes blistering and peeling of the paint film. Adulterants as pigments, such as chalk, gypsum, talc, etc., are mostly valueless. Some are soluble, while others contain or absorb water, and others again hold attacking acids in combination.

Linseed oil, in either the boiled or raw form, is the principal vehicle used in paint manufacture. The former contains less water than the latter, and is superior on this account.

The best possible combination is a lead priming coat, covered with a high-grade graphite, pigments being mixed in a good quality, well-prepared, boiled linseed oil. Cheaper pigments will serve under certain conditions or if temporary coatings only are desired for special purposes.

The process of application determines very largely the value of the paint coat. Careless application can render a good coat valueless. Unless the steel work is thoroughly cleaned of all rust before coating with paint, rapid destruction cannot be prevented by the highest grade materials. The removal of the rust may entail the use of the sand-blast, but a coat of whiting is as useful as a lead paint if the rust is left on. Driers of the volatile type, by making the film porous, prove detrimental, the escape of bubbles of gas making holes which do not close, thereby rendering the underlying metal accessible to attack.

If paint is applied too thickly the top dries, leaving the core plastic. This condition makes a film susceptible to peeling or rupture. Two thin coats are better than one thick one, since the second one will largely correct the deficiencies of the first. Experiment indicates that four coats at least are necessary to give an impervious finish.

No paint is a permanent protection against rust, but reasonable results can be expected if high-grade materials are used and care is shown in the selection of the ingredients and in the application of the paint.

The Council of the Canadian Society of Civil Engineers has appointed from its members an executive committee, with a view to dealing with urgent matters. This will save a considerable amount of time, as the matters will be dealt with each week.

Manufacture of Munitions as a Permanent Asset to Canadian Industry

By Col. David Carnegie[*]

I SHOULD like to refer first to Canada's capacity to produce munitions; second, to the permanent assets to Canadian industry arising out of munitions work; and, third, to the responsibility of engineers in developing these assets.

Canada's Capacity to Produce Munitions

In September, 1914, when General Sir Sam Hughes undertook the first order for shrapnel shells Canada's capacity to produce shells amounted to 340 18-Pr. shrapnel shells per week. These were made at the Dominion Arsenal, Quebec. The capacity of Canadian factories to-day approximates 400,000 18-Pr. shrapnel complete rounds per week, including cartridge cases, primers, fuses, and propellants. In addition to this amazing output there is a weekly capacity in Canada for nearly 400,000 high explosive shells, ranging in sizes from 18-Prs. to 9.2 in., making an approximate total weekly output of 800,000 shells. This large output, along with other supplies made independently, requires about 25,000 tons of steel per week, 2,500 tons of brass, 750 tons of copper, 250 tons of zinc, 1,500 tons of lead, 200 tons of antimony, 150 tons of resin, several tons of ferro-molybdenum, and about 500 tons of cordite, 500 tons of trinitrotoluol, and 300 tons of nitrocellulose powder.

Over 300,000 boxes are required for these shipments per week, and about three and one-quarter million lineal feet of board are used in making these boxes.

The weekly value of these products can only be understood by people who have learned to think in millions. The total value of orders for munitions placed in Canada approaches eight hundred million dollars and the value of the munitions shipped is close upon five hundred million dollars.

The Amount and Value of the Plant Employed in Producing Munitions

Looking again at the magnitude of munitions work in Canada to-day, we see 650 factories engaged in 144 towns scattered throughout every province of the Dominion except Prince Edward Island. Cities as far apart as St. John, Newfoundland, and Victoria, B.C. (a distance approximating 4,500 miles) are contributing to the output. Manufacturers from almost every industry in Canada have turned their attention to the production of munitions, and it is gratifying to record that few of them have failed in producing the standard of work required.

Some idea of the amount of plant and machinery installed can be obtained when it is remembered that apart from the large increase in the number of steel-making furnaces which have been installed since the war commenced, there are 26 contractors making shell forgings, with total forging press capacity of 61,000 tons. This tonnage is represented by 162 forging presses, the largest having a pressure of 1,500 tons and the smallest 200 tons. In order to feed these presses with steel for forgings 200 furnaces have been built. The presses are driven by 120 sets of pumps, having a total electric motor capacity of 21,000 h.p. The approximate value of shell forging plant machinery installed is estimated at $5,000,000.

Coming to the plants for the machining and assembling of shells and the manufacture of component parts, there have been installed over 18,000 machines and 90,000 h.p. to drive them, the estimated cost approximating $35,000,000.

Gauge Production

One can hardly mention this subject without being reminded of the almost insuperable difficulties which were presented in the early days of the war in obtaining gauges for munitions. We can never thank the United States manufacturers sufficiently for what they did in coming to our aid at that time. The special skill in making gauges to the limits of accuracy required could not then be found in Canada. To-day there are at least 20 factories producing gauges in Canada; and while we are not independent of help from the States, some idea of the magnitude of the work can be understood from the monthly bill, which amounts to over $150,000 for new gauges.

During the month of March about 10,000 new gauges and checks were inspected. The usual accuracy called for on a gauge is .0003—3/10 thousands of an inch; and for a check. 1/10 thousand.

An army of over 5,000 examiners are engaged upon the inspection, under the direction of Colonel Edwards and his staff of officers.

Production of Copper, Zinc, and Other Metals

In addition to the production of steel, the manufacture of forgings, the machining and assembling of shells, and the manufacture of cartridges, cases, fuses, primers, and other components, the mining and metallurgy of metals for munitions manufacture have played an important part in Canada. Copper and zinc are now refined in the Dominion instead of being sent in the form of concentrates of zinc and copper matt to the United States for refining there. Copper products, such as copper bands, are now being manufactured in Canada on a commercial basis. Brass cartridge case material, so difficult to obtain in the early months of the war, is now being made successfully in Canada. Other materials, such as lead, antimony, arsenic, tungsten, molybdenum, and aluminum, have been produced for munitions.

Production of Explosives

Side by side with these developments there has grown a capacity for explosives even greater in proportion than that of metals. In order to complete what we call the fixed 18-Pr. round of ammunition, it is necessary to make cordite or nitrocellulose powder, and while experimental amounts of cordite had been produced before the war, Canada's capacity to-day approaches 1,000,000 pounds per week of both cordite and nitrocellulose powder.

One of the principal explosives used for bursting shells, known as trinitrotoluol, has been made successfully in Canada for over two years from the by-products of the coke ovens. To-day the production approaches 1,000,000 pounds per week.

National Factories

Among the many contributing features of successful production to-day started by Mr. Flavelle soon after he became chairman of the Imperial Munitions Board was the creation of great national factories in Canada. In addition to stimulating and developing companies in Canada he set in operation several national factories for the loading of fuses, the manufacture of gun cotton, acids, trinitrotoluol, aceton, cordite. nitrocellulose powder, aeroplanes, and electric steel.

These factories are operated by separate companies, the entire stock of each company being held by the Imperial Munitions Board.

In this connection it is interesting to know that aeroplanes are being made in Canada at about the rate of one per day, and when the new factories are completed five per day are expected.

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[*] Member and Ordnance Advisor of Imperial Munitions Board. Abstract of address to Ottawa Branch C.S.C.E.

Permanent Assets to Canadian Industry

Hurrying from these few facts about the output of munitions in Canada, without even touching upon what would be a fascinating subject to you as engineers (I mean the scientific processes involved), and also leaving entirely out of consideration the gruesome purpose in actual warfare for which the munitions are required, I pass on to consider the value of this unholy business as a permanent asset to Canadian industry. I should like to divide the total value of the permanent assets, as I view them, into two parts—the first resulting from the standardization of products, the second from the standardization of skill.

1. The Standardization of Product

No component part of munitions, however insignificant, has been made or accepted on the old principle of "good enough." Every part has been supplied to drawing and specification, with rigid examination, analysis, and test, before acceptance.

I think I am safe in saying that there is no industry in Canada which has been occupied in the manufacture of munitions but has passed through a process of refinement, which will leave it in a better condition when it returns to domestic pursuits after the war. If you review the great industries of Canada it will be difficult to find one which has not been actively contributing to the output of munitions.

Industries such as the iron and steel, the metals and metal products, refractory materials and fuels, lumber and timber, leather, textiles, paper, chemicals, and other minor industries, have called into being processes and plant which could be adapted for munitions, and have also added new processes, new equipment, and new skill where these were required.

In addition to the employment and adaptation of existing industries for munitions manufacture, entirely new industries have been brought into activity. The manufacture of munitions has given an abiding impetus to the mining and subsequent operations in the production of coal, iron, copper, nickel, zinc, molybdenum, antimony, aluminum, and other metals.

The chemical industries have been accelerated by utilizing the waste products of the coke ovens for the manufacture of high explosives. These waste products after the war will be turned, by ingenuity and skill, into valuable domestic products.

The electro-chemical industries, such as the refining of copper, zinc, and lead, have been initiated, and will remain as a commercial asset. The electro-thermic processes for the production of ferro alloys, such as ferro-silicon, ferro-manganese, ferro-molybdenum, aluminum, magnesium, and other metals, have produced standardized products.

It has been a costly, and sometimes bitter, training, but it has been done ungrudgingly and with great patience; and, as a result, the standard of Canadian products to-day is greater than ever before.

2. Standardization of Skill

The widespread knowledge of new processes, involving the scientific study of metals, the flow of materials, and their physical, chemical, and metallurgical values, has been such that one can hardly imagine it would have been possible for the universities and technical schools of Canada to have provided such instruction in the course of many years which has been crowded into as many months. Every workshop has been a school of training in standardizing its skill. Every factory in which steel is made and forged is now partly or fully equipped with the means for measuring temperatures and intelligently discovering the value of the materials with which they are working. In every workshop in the different provinces of Canada where shrapnel shells are made the scientific treatment of steel is known. There is hardly a town of any importance in which the use of precision instruments and gauges for measuring shells and their component parts does not exist.

It is difficult to assess the value of this skill to Canadian industry, in which over 250,000 workers have become skilled in the art of such processes and the manipulation of such tools and gauges. It is more surprising still to know that nearly 12,000 women have become skilled in this work. Never in the history of the world has there been such an incentive to acquire such skill for a purpose the like of which our civilization should be ashamed, but which is nevertheless an asset which will be of great value in the peaceful commercial industries for the expansion of Canada.

The Responsibility of the Engineer in Developing These Permanent Assets

Gentlemen, ours is an honorable profession, one crowded with vistas of research and delights, the like of which even the angels might envy. This war has awakened the slumbering forces in the human mind and brought into activity engineering genius unequalled in quality hitherto. Your great waterfalls have been transformed by your skill into the most resourceful agency of power, without which we would have hopelessly failed in reaching the output of munitions named. Your skill has mined, smelted, and fabricated the many metals which have proved to be of such value for munitions. The great engineering plants which have been brought into being by your skill are monuments of industry which must not be allowed to rust when this war is over. There is a great responsibility resting on you as engineers and leaders of industrial thought and action. It is greater to-day than ever before in the history of Canada. The opportunity given to you of taking and intelligently using and directing those assets of which I have spoken is of vital importance to Canada's successful industrial development. There is no need to wait for royal commissions. Power and authority are vested in yourselves; nothing will be too great for you if you see your opportunity, and if you have faith in the engineering talent of Canada. The man who was afraid and went and hid his talent in the earth brought forth the most scathing reproof ever uttered.

If I were to venture to suggest a program for your immediate consideration, I would advise you to classify and value the engineering skill of your societies, with the object of forming in Canada from their membership small committees of scientific, technical, and commercial men, who would be responsible for obtaining from the accumulated reports of commissions and numerous supplies of information stored in government departments and elsewhere relating to the best standardized processes, equipments, and plants for the development of the industry they represented. Each committee would, therefore, become the recognized source of classified information, to whom manufacturers could with confidence refer for any help and advice required.

If your inventory of classified ability were broad enough to include the fuller issues in developing the standard of products, skill and utilitarianism, I should utilize every willing member of your profession, making committees, say, of members not exceeding three, for the consideration and report of the following subjects:

1. Industrial, technical, and commercial education for our boys and girls before and after leaving the day school.
2. The classification and valuation of labor.
3. The remuneration and hours of labor.
4. The direction and character of employment in classified industries.
5. The provision of methods for the prevention of unwholesome competition between manufacturers.

6. The provision of definite standards for checking the formation of doubtful companies.

Then, with a central authority, you could co-relate the efforts and information of your scientific and industrial committees for a broader policy of universal trade.

Canada's Big Opportunities

By the consideration of some such programs those valuable assets which are now the heritage of the Canadian people will make this country prosperous. Canada has its opportunity to set the pace in the world's industry. Its finances were never better. Last year its exports exceeded its imports by $340,000,000. Its natural resources cry out to you for their development. It is a country in which there is a heritage of wealth far exceeding that with which our youthful imaginations surrounded "Treasure Island." Your efforts in embracing those opportunities will be strengthened by a more complete education of the industrial workers, and by a heartier co-operation with the employees.

A nation, said President Wilson, is as great, and only as great, as its rank and file. Will you gentlemen see that the rank and file who make this nation follow those lofty standards of education and sacrifice which make life great? It would be terrible if we missed the way after such a struggle.

There is a great industrial war before us, for which we are unprepared. This might have been avoided if a harmonious united federation of the world's industrial councils were possible. No doubt the distant future will produce the genius for such an undertaking. Meanwhile we cannot escape the responsibility before us.

Since the war started the eyes of the world have been turned towards Germany. The history of that country, the characteristics of its people, and the success with which for years prior to the war they flooded the markets of the world with products, the prices of which became almost a menace to all other manufacturing countries, have inspired a determination by the people of the competing countries to put their industrial house in order to meet all reasonable competition. German militarism will be crushed before the Allies sheath their swords, but to crush the industrial spirit in the Germans, which has made their country prosperous, would be to destroy the very spirit we now seek to stimulate in ourselves. The industrial prosperity and triumph which put Germany before the war in the front rank of the world's commerce can never be crushed—indeed, it would be folly to attempt to crush it. The world demands the best from every nationality, and amongst the many lessons this war has taught the nations of the world is the very old and common one—that out of persistent and well-balanced, indomitable courage comes the ability which brings success.

An Industrial War Is Coming

Peace is coming; when it is declared, the struggle for industrial supremacy will intensify in the German people. The very qualities of sacrifice, courage, endurance, enterprise, and genius which this war has developed throughout Canada and the British Empire, among our Allies and our foes will not by any chance lose their value on the Germans; but, on the contrary, if, as we believe, German military arrogance will be swept away, her industrial classes will, by reason of the opposition to her commerce and trade, struggle to maintain a higher efficiency within her borders. Before many years the world's markets will be flooded again with products at much lower prices than it is even now possible to conceive, with the result that hate and prejudice to German goods will die away before a temptation so strong that the purchasing value of the wage-earning classes will find it necessary to buy in the lowest markets, although the products be from Germany.

One can imagine, judging from the procedure in the past, that since the war began the accumulation of products in Germany, the outlets for which have been closed, will be dumped on the world's markets immediately peace is declared, with a new propaganda which these closed years have inspired. The very thrift which privation and sacrifice have demanded from the people will encourage even more than ever the utilization of every form of waste product.

Table of Types of Electric Furnaces by Countries of the World Operating or Contracted for on Jan. 1, 1917
With Totals for 1916, 1915, 1913 and 1910

	Heroult	Girod	Induction	Stassano	Keller	Chapelet	Nathusius	Snyder	Wile	Rennerfelt	Grönwall Dixon*	Greene	Special	Greaves-Etchells	Total Jan. 1, 1917	Total Jan. 1, 1916	Total Jan. 1, 1915	Total July 1, 1913	Total March, 1910
Germany and Luxemburg	19	5	19	2	3		4								52	[illegible]	46	[illegible]	[illegible]
Austria Hungary	10	2	3	2						1					18	18	18	16	15
Switzerland	1	2						...		1					4	4	3	2	[illegible]
Italy	4		2	13	5	5									29	[illegible]	22	[illegible]	11
France	19	7	2							1					29	11	17	[illegible]	23
Great Britain	34	1	2	4				6		7	14			20	88	46	[illegible]	16	7
Belgium	2	1													3	[illegible]	[illegible]	[illegible]	[illegible]
Russia	3	1	1	2						7	2				16	11	[illegible]	4	2
Sweden	3		1							34	2				40	23	18	[illegible]	[illegible]
Norway			2						1	6					9	6	[illegible]	5	
Spain			1								1				2	[illegible]	1	1	
Japan	1		1												2	1	1	1	
Mexico			1												1	1	1	4	3
Australia											1				1	1	1		
Chile																1			
Roumania	1														1				
Location not given			12										9		21	9	[illegible]		
Total outside the United States and Canada	97	19	47	23	8	5	4	6	1	57	20		9	20	316	222	170	[illegible]	101
United States	79	4	3	1				19	1	13	8	1	7		[illegible]	[illegible]	41	19	10
Canada	5							3			1		10		[illegible]	8	2	[illegible]	[illegible]
Total in U. S. and Canada	84	4	3	1				22	1	13	9	1	17		155	81	43	22	13
Grand Total in World	181	23	50	24	8	5	4	28	2	70	29	1	26	20	471	303	213	140	114

*Electric metals in Great Britain

This table is of interest as showing the vast increase in electric steel furnace installations caused by war demands.

Report of Nova Scotia Water Power Commission

A progress report for 1916 by the Nova Scotia Water Power Commission, covering their investigations to September 30, 1916, has just been published. Work has been carried on throughout the province under the co-operative agreement between the Nova Scotia Water Power Commission and the Dominion Water Power Branch by Mr. K. H. Smith, resident engineer, in charge of the investigations. The work dealt with by this report covers operations up to September 30th last, and shows what has been accomplished for the period from the organization of the field studies in May, 1915. The Commission has carefully examined the report of the resident engineer, and feels that much satisfactory progress has been made in assembling the necessary material so that the Commission may be able shortly to present recommendations for the framing of rules and regulations respecting the development of water-powers in the province.

The report of the engineer is not intended to be final in any particular, but is prepared with the intention of making available to the public such information as has already been collected. All estimates of available power are subject to revision as further stream-flow records accumulate, while the stream-flow records themselves are subject to certain corrections as additional actual measurements of flow become available.

The power studies so far made have given promising results. The most unsatisfactory element in all these studies, however, has been the inadequacy of existing stream-flow records, and the necessity of giving special attention to the hydrometric phase of the present investigations is clearly indicated. At the same time, many of the larger rivers of the province remain to be studied and field surveys, in addition to the hydrometric work, are being carried out as rapidly as available funds permit. It is the intention to pursue vigorously this work until at least all the more important rivers of the province have been investigated.

Conferences have been arranged during the year with the Dominion Water Power Branch through its hydraulic engineer, Mr. J. T. Johnston. Additional assistance has been accorded the Commission in loaning the services of two of the engineers of the Dominion Water Power Branch, one of whom continues with the Commission and has rendered much assistance in the preparation of the report submitted by Mr. Smith. The Commission desires to record its appreciation of the assistance that has been rendered by these services. The co-operative agreement between the Commission and the Honourable William J. Roche, Minister of the Interior, expires in March, 1917, but plans are being made on the assurance of a renewal of the previous arrangements.

The report is signed by the members of the Commission, Messrs. Hiram Donkin, Chairman; Frederick H. Sexton, Wm. G. Yorston, and Arthur S. Barnstead, secretary.

"The 141st Meridian"

Mr. J. D. Craig, A.M.Can.Soc.C.E., assistant superintendent of the Geodetic Survey of Canada, addressed the Ottawa Branch of the Canadian Society of Civil Engineers at their fourth meeting for the year in the lecture hall of the Carnegie Library, on the subject, "The 141st Meridian." The address was illustrated with lantern slides.

New Books

Use of Water in Irrigation—by Samuel Fortier, D.Sc., etc., chief of Irrigation Investigations, U. S. Department of Agriculture. McGraw-Hill Book Co., Inc., New York, publishers; price $2.00. This volume deals with the agricultural side of irrigation and aims to benefit three classes of readers—new settlers, irrigation farmers and students in agricultural schools. The subject matter is confined almost exclusively to the irrigated farm and to the problems which confront the irrigator. Considerable space has been given over to the method of preparing land and applying water. The present issue is the second edition, in which the article on the measurement of water has been revised and enlarged and a new article added on sewage irrigation. The most important change consists in the addition of a new chapter on the use of water in foreign countries. 325 pages, 8 x 5 ins., approximately; bound in red cloth and well illustrated.

Mainly Constructional

East and West—From Coast to Coast

A report on a proposed filtration plant for Pointe Claire, P.Q., has been made by Messrs. R. S. & W. S. Lea, Montreal. At present a chlorinator is being installed.

The city of Winnipeg proposes to make extensions at the hydro-electric power house at Point du Bois. The estimated cost is between $175,000 and $180,000

The building permits issued in Galt, Ont., during the month of April totalled $24,375, an increase of $11,000 over the same month last year. The largest permit was for a $10,000 addition to the factory of Newlands & Company.

Building permits issued in Welland, Ont., during the month of April this year amount to $53,469, as compared with $20,086 in April, 1916. The total for the first four months of the year was $95,299, as against $30,124 during the corresponding period last year.

Six district engineers, out of 55 applicants, have been appointed by the provincial government of British Columbia, taking the place of the road superintendents dismissed last November. These engineers, however, have extended powers and additional responsibilities.

A by-law governing the collection and disposal of garbage has been passed by the council of Renfrew, Ont. It provides for operation of the system till the end of October as an experiment, and will then be revoked or amended in the light of the season's experience.

If suitable accommodation can be obtained a military hospital of 300 beds will be located in London, Ont. Enlargements are suggested on the Victoria Hospital site, which would be built jointly by the Hospital Commission, the Provincial Government, and the city of London.

Building permits to the amount of $19,995 were issued at Guelph, Ont., during the month of April. The Gilson Manufacturing Company are erecting an addition to their factory and the Homewood Sanitarium is building a new laundry. The permits this year to the end of April total $37,564.

During the month of April there were 47 building permits issued in the city of Kitchener, Ont., at a value of $75,897. For the first four months of the year there was a total of 70 permits issued, valued at $94,427, compared with 30 during the corresponding period last year, valued at $50,495.

On the recommendation of the Board of Health, the town of Renfrew, Ont., is considering the installation of an additional filter. Town Engineer Stewart has been instructed to prepare plans and specifications for a filter of the same capacity as the one at present in use and secure prices as soon as possible.

Montreal's building permits for April number 215 and are valued at $622,940. This compares with 221 permits valued at $435,805 in the same month last year. For the first four months of the year there were 408 permits issued at a value of $1,618,860, as compared with 439 permits during the corresponding period last year, valued at $919,225.

An agreement considered between the city of Peterboro and the Quaker Oats Company in regard to the company again establishing their plant in that city, provides for the erection of bridges on Hunter Street and Hazlitt Street. The former, according to an estimate furnished by City Engineer Parsons, will cost $245,000, and the latter $20,000.

A new school has just been completed in Campbellton, N.B., in Ward 111. It is a two-storey brick structure, finished in the interior with native birch and Douglas fir. It contains four large class rooms, halls and basement. In planning the building, provision was made for a future addition of equal size should the growth of the town make this necessary.

A new cement company, with a capital of $1,250,000, has been formed to operate a cement mill at Neuville, County Portneuf, P.Q. The mill, now being built, will have a capacity of 1,500 barrels. The property formerly belonged to the Canada Cement Company, and was purchased from that company. Mr. C. C. Lapierre, formerly of Montreal, organized the new concern.

A sum of $46,000 has been appropriated by the municipal council of St. John, N.B., for the erection of a power house and laundry at the General Public Hospital grounds. The building will be of brick and concrete, two storeys in height, and will cover an area 66 x 64 feet on the southwest corner. For the building proper the cost of erection is estimated at $23,000, and the remainder of the appropriation will be required for equipment.

Messrs. R. S. & W. S. Lea, Montreal, have prepared plans for a reinforced concrete reservoir of half a million gallons capacity for the city of Three Rivers, P.Q. The supply will be taken, as heretofore, from a number of wells, and the proposed reservoir is primarily for fire protection purposes. The old pumping station will be used for the present, but it is proposed to erect in the future a new station. The work on the reservoir is to be done by day labor.

A question which is causing some discussion in St. John, P.Q., is the proposal to borrow money to pave Main Street, complete the sewer system and do further work on the laying of sidewalks. The estimated expenditure is in the vicinity of $60,000, $25,000 of which would go toward completing the sewerage system, and $20,000 to the paving of Main Street to Merry Street, a distance of about half a mile. A by-law may be submitted shortly by the council, asking authority to borrow this amount.

The railway commission has ordered a subway at the Lyn Roads crossing over the Grand Trunk Railway, near Brockville, Ont. The cost of the subway is divided as follows: 20 per cent. railway grade crossing fund; 15 per cent., corporations of counties of Leeds and Grenville; 15 per cent., township of Elizabethtown, and 50 per cent., the railway company. The work of the subway is to be done by the G. T. R., and the necessary highway diversions, by the two municipal councils.

This week, commencing April 30, is clean-up week in Hamilton, Ont. The Board of Trade was instrumental in organizing the campaign, which was advertised throughout the city. Extra facilities were provided by the Board of Works to take care of the large amount of waste which is expected as a result of the citizens cleaning up their premises. The teachers were also requested to point out to the school-children the advantages of making the city an attractive place to live in.

The bathhouse which is being erected at Port Stanley, Ont., for the London & Port Stanley Railway Commission, is now nearly completed. This building is about 350 feet long and has accommodation for 1,000 people. Various other improvements are being carried out by the Commission. The land for the new grain elevator is being cleared and work will likely be begun very soon. The construction of a large new breakwater to the west of the present piers will also be commenced at once.

When the present plans for the construction of aviation schools for the British Government are completed by the Imperial Munitions Board, Canada will have four centres at which officers will be trained for the Royal Flying Corps, and close on 1,000 planes will be in use. The aerodrome at Camp Borden is now in operation, and another in the Bay of Quinte district is being constructed as rapidly as possible. Later it is proposed to provide a school a short distance north of Toronto. Finally, a school is to be located in British Columbia, where the Imperial Munitions Board has already leased two sites—300 acres in the Delta on Boundary Bay and 275 acres on Lulu Island. Each of these plants will cost in the neighborhood of $700,000.

A delegation representing the city of Toronto and eleven other municipalities affected by the widening of the Toronto-Hamilton highway appeared before the Ontario Railway and Municipal Board recently, to examine the proposals of the Highway Commission, which is seeking authority to widen the highway from the west limits of O'Connor's Road to the western limit of the city of Toronto. The chief point of difference between the municipalities and the highway commission arose as to the apportionment of the cost of the widening to each municipality. The board finally ruled an adjournment of two weeks on the understanding that the Highway Commission submit a statement of apportionment of cost to each municipality affected. The estimated cost of the section of the road in question, according to the proposal submitted by the Commission, will be $314,771.

The Dominion Railway Board have granted the application of the C. P. R. to double-track its main line from North Toronto station to Leaside Junction. The plans of the railway company, as approved by the board, call for the erection of new bridges over two ravines and highway crossings over Summerhill Ave., Maclennan Ave., Bay View Ave., and Todmorden Road. The city of Toronto and the Civic Guild had strongly opposed the application on the grounds that the scenic beauty of the ravines would be spoiled and had requested instead that a subway be built at Summerhill Ave. at the expense of the company. The C. P. R. plans to build bridges over the ravines on the north side of its existing bridges and the board refused to intervene as the work will be done on the company's right-of-way. The building of a new bridge adjoining the one just east of Summerhill Ave., instead of enlarging the existing bridge, as the city desired, will mean a saving of about $40,000.

Personals

Messrs. R. S. & W. S. Lea, consulting engineers, have removed from 820 to 809 New Birks Building, Montreal.

Mr. J. R. Barlow, superintendent of the Montreal roads department, has lost his son, Lance-Corporal Barlow, killed in action. Mr. Barlow has two other sons at the front.

Mr. F. L. Macpherson has resigned as municipal engineer of Burnaby, B.C., and has accepted an appointment by the provincial government of British Columbia as engineer for district five. Mr. Macpherson had been Burnaby's engineer for the past seven or eight years.

Mr. S. R. Badgley, the designer of the Massey Music Hall, Toronto, died recently in Wycliffe, Ohio, near Cleveland, having reached an advanced age. Mr. Badgley was considered one of the leading architects in the Middle States and designed many other notable buildings.

Mr. E. R. Gray, B.A.Sc., who formerly held the position of deputy city engineer and latterly joint manager of the works department of Hamilton, Ont., has been placed in charge of the works department of that city, with the title of city engineer and manager of the waterworks and sewage disposal works.

Mr. F. Tissington, Chief Engineer of Mackinnon, Holmes & Company, Limited, Sherbrooke, has resigned his position and is taking a short holiday before commencing work again. Mr. Tissington has been with this firm for the last five and a half years, formerly as chief draughtsman and for the last few months as chief engineer.

Mr. S. L. Squire of Waterford, former president of the Ontario Good Roads Association, and now honorary president of that organization, has been appointed to the position of municipal adviser in the Ontario Highways Department. His duties more particularly will cover the work of explaining the provincial policy on highways improvement to counties and other municipalities which have been hitherto somewhat backward in taking advantage of the legislation in this regard. Mr. Squire is a merchant of Waterford, and has been active in municipal matters for some time

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Aurora, Ont.
Plans have been prepared for $80,000 sewage system for the town. Engineers, James, Loudon & Hertzberg, Excelsior Life Bldg., Toronto.

Cap de la Madeleine, Que.
Town Council plan concrete sidewalks costing $3,500. Secretary, A. Bourque, N.P.

Eastview, Ont.
The Town Council plan concrete sidewalks costing $5,000. Engineers, Patterson & Byrne, Sparks Street, Ottawa.

Merritton, Ont.
Tenders received by the Clerk, R. Clark, until noon, May 14, for the construction of 575 feet by 15 inches, 1,265 feet by 12 inches, and 2,270 feet by 10 inches, sewer pipe for the Town Council. Plans and specifications with the Engineer, F. N. Rutherford, 24 Queen Street, St. Catharines.

Ottawa, Ont.
Tenders will be called in June by the Department of Public Works, Dominion Government, for the construction of concrete pavement costing $16,000.

Regina, Sask.
The City Engineering Department plan paving of lanes costing $30,000. Engineer, D. A. R. McCannel.

Saskatchewan, Province of
The City of Regina and Government of Local Municipality plan construction of sixty miles of pavement.

Three Rivers, Que.
In connection with waterworks extension for the city the city engineer, Z. Lambert, is in the market for 1,000 barrels of cement, 525 cubic yards of structural and reinforcing steel, 2 pumps, capacity 2,500,000 gallons per day, three stages; 2 pumps, capacity 3,000,000 gallons per day, three stages.

Toronto, Ont.
Work of paving Humber Boulevard will be proceeded with by Parks Commissioner Chambers. Eight hundred ft. rocmac and 3,100 ft. concrete. Cost, $15,000.

Winnipeg, Man.
City Council plan purchase of water meters. City Engineer, W. P. Brereton, 223 James Avenue.

Woodstock, N.B.
The Town Council plan water system. Engineer, A. G. Fields.

CONTRACTS AWARDED

Ottawa, Ont.
O'Leary, Ltd., Bank Street Chambers, has general contract for pavement of Albert Street for the city.

T. G. Brigham, 85 Duke Street, has general contract for pavement costing $20,000 on Gloucester Street for the city.

The tender of Commissioner of Works, A. F. Macallum, City Hall, has been accepted for pavement on Melrose, costing $9,000, for the city.

Quebec, Province of
Laganiere & Houde, Gronidines Co., Pordreuf, have the general contract for asphaltic concrete pavement costing $145,000 for the Quebec Road Commissioner, Parliament Bldgs., Quebec.

Railroads, Bridges and Wharves

New Westminster, B.C.
The Canadian Northern Railway and the Canadian Pacific Railway plan union station. General manager, C. N. R., Mr. MacLeod, C. N. R. Station, Edmonton. General Manager, C. P. R., Calgary.

St. Thomas, Ont.
City Council plan street railway extension costing $40,000. Engineer, M. Ferguson.

CONTRACTS AWARDED

Three Rivers, Que.
Chas. Page has the general contract for repairs costing $15,000 to aqueduct wharf for the city, and will be in the market for 7,000 to 8,000 pounds of spikes, screws, bolts, and iron plates.

Chas. Page, Des Anges Street, has general contract for $19,000 wharf for the Canadian Iron Corporation, St. Maurice Street.

Montreal, Que.
The Turnbull Elevator Co., 511 St. Catherine St. W., have the contract for elevators for the $175,000 station for the Canadian Northern Railway, Dorchester Street.

Public Buildings, Churches and Schools

Battenburg, Alta.
Tenders received by the secretary-treasurer, Charles Brumfit, until noon, May 19, for erection of brick school for School District of Creuzot, S. D. No. 34. Plans and specifications with A. M. Jeffers, McLeod Building, Edmonton, or the secretary-treasurer.

Blue Sky, Alta.
Plans and specifications with the secretary-treasurer, Harry Hanmer, G. W. 8-81-1, West 6, Meridan, who will receive tenders until May 18 for erection of school for School District No. 3330.

Bridgeburg, Ont.
Tenders received by the architect, C. M. Borter, Main Street S., Niagara Falls, or the Secretary of Board, Geo. Tait, until May 14, for erection of $20,000 brick school for the County Council. Plans and specifications with the architect.

Halifax, N.S.
Tenders will be called shortly for erection of an addition to hospital for Dr. A. Ivan Mader, 59 Morris Street. Architect, A. R. Cobb, Tramway Bldg.

Hamilton, Ont.
Plans and specifications with the architect, Brigadier Gideon Miller, James and Albert Streets, Toronto, who is receiving tenders for $20,000 hollow tile and brick addition to hospital for the Salvation Army, 27 Mountain Street.

Hazelwood, Alta.
Public School District plan school. Secretary-treasurer, W. B. Moulder, Hardisty.

Limerick, Sask.
The Town Council plan hospital. Secretary-treasurer, Chas. M. Wilson.

London, Ont.
Tenders wanted by the Chairman of the Building Commission, J. F. Maine, 84 Byron Ave., until May 15 for the erection of $7,000 brick parsonage for the Askin Street Methodists. Plans and specifications with the chairman.

Niagara Falls, Ont.
Plans and specifications with the architect, C. M. Borter, Main St., Niagara Falls S., who will receive tenders until May 11 for erection of a $12,000 brick fire hall for the city.

Richdale, Alta.
Public School Board plan school. Secretary-treasurer, J. E. Hunter.

Saanich, B.C.
Tenders will be called shortly for $7,500 school for the School Board. Architect, C. Elwood Watkins, care of owners.

St. John, N.B.
Tenders received by the architect, F. Neil Brodie, 42 Princess Street, until May 14 for erection of a power house and a laundry costing $23,000, for the General Public Hospital.

Sydney, N.S.
Alex. Cameron, Victoria Road, has the general contract for $10,000 frame church for the Greek Episcopal.

Vancouver, B.C.
The School Board plan alterations to ventilating system in a number of schools to cost about $80,000. Engineer of School Board, Walter Leek.

Verdun, Que.
The Verdun Hospital for Insane, Board of Trade Bldg., Montreal, plan addition to asylum.

Wyoming, Ont.
Tenders received by the Pastor until May 16 for erection of a $15,000 brick church for the Methodist Congregation.

CONTRACTS AWARDED

Chatham, Ont.
Reid & Brown Structural Steel & Iron Works, Ltd., 63 Esplanade St. E., Toronto, have the contract for steel work for the $38,000 addition and alterations to school for the Board of Education.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 May 16, 1917 No. 20

Principal Contents

Page
Editorial 429
The Pantages Theatre, Vancouver, B.C. 431
A Definite Scheme of Road Organization 433
Railway Commission's Report 435
Timber Decay and its Growing Importance to the Engineer and Architect 437
Cement Concrete Roadways of Ontario 439
A New Form of Septic Tank 442
The Water Powers on Western Rivers 444
Practical Hints for the Contractor 446
Mainly Constructional 447

Fire Waste and Production

PRODUCTION is the most urgent problem before this country at the moment. At a time when the entire world is threatened, as perhaps never before, with a calamitous starvation, our endeavors and energies should be, and fortunately are being, concentrated on a more abundant productivity. Every day evidence is provided to show that the people of Canada are listening to the call of the land and that this year will be a record-breaker in so far, at least, as the area of soil under cultivation is concerned. It is with a profound sense of duty that this journal backs up, before all else, the Empire's needs at this time. Our efforts are all exerted towards a winning of this war as speedily and expeditiously as may be, and to this end, the call for greater production should be enthusiastically acted upon by every individual.

There is one side of the greater production question, however, that has, we fear, been largely overlooked. Production is no more important than preservation—the proper protection of what food products there may be now or later. Our attention is directed to this matter by data recently issued by E. P. Heaton, Fire Marshal of Ontario, applying to the loss of field products through fire. The elimination of the stupendous waste through fires is a matter regarding which efforts might well be directed, now that production is the all-important need. In Ontario alone the fire loss for the first quarter of the present year amounted to over three and a quarter million dollars. Unless stringent efforts are exerted to overcome this, the year's loss gives promise of being considerably more disastrous than even 1916's twelve million dollar fire waste. Although fire is always calamitous, in war time it is even more so, for the losses sustained can be ill-borne, and the burdens thereby developed are just so much added to the country's war responsibilities.

* * *

There is one phase of the fire waste problem, however, that is more directly related to the need of greater production. This is the unfortunate destruction of field products in barns, elevators, warehouses, canning factories, cereal mills and other places where the raw product is being stored or turned into food for the needs of ourselves or of our armies. To illustrate, Mr. Heaton states that in Ontario alone, during the last year, over 600 barns were destroyed, the loss in produce, implements and live stock being placed at $600,000, out of a total loss of $1,000,000. At least half of this loss is considered preventable with a little care and thought. This waste is the most unfortunate part of the whole fire loss matter, at the present time especially, for it means a destruction of what is produced and thereby renders naught an appreciable portion of the labor expended in making the soil fruitful. The example cited is but typical of the situation in all localities. Ontario does not afford an isolated instance of serious barn loss through fire. Every other province in the Dominion can show its quota of such destruction, and as large a proportion of it can safely be regarded as unnecessary and hence, purely wasteful.

A greater degree of preservation of products and a more thoughtful attempt to counteract fire destruction will give a very effective answer to the appeal that is urging the people to heed an Empire's needs. If, as Mr. Heaton states, $300,000 worth of field products are savable in Ontario alone, the prevention of such a loss will be the equivalent of an equal amount of extra production. Preservation of what is produced is as important as the production itself and in counteracting this not unsignificant barn loss, and all fire waste in general, the people will be showing a spirit of readiness and willingness to take up the country's call.

* * *

By way of guidance in effecting this very necessary move, we append three very simple suggestions made by Mr. Heaton which, if adopted, will result in appreciable savings:—

1. Install lightning rods on barns and save fires from lightning. (The Department of Agriculture, Parliament Buildings, Toronto, will furnish anyone with

a pamphlet showing how the rods should be made and erected). It is an absolute fact that barns properly rodded and grounded are not liable to be struck by lightning.

2. The crops should not be put in until it is certain they have been properly cured. Evidence is daily accumulating that the heavy clover crops of last year did not receive full and proper care and resulted in the firing of barns from spontaneous combustion. Many doubt this theory, but recognition of the cause is growing very rapidly.

3. Ventilate the barn so that gases caused by the fermentation of imperfectly cured crops will be successfully carried off. In an unventilated barn to keep the doors and windows closed after harvest, and then admit air by the opening of the doors, windows, or other apertures during the warm fall weather is to invite the fire fiend to get in his work.

At the Country's Service

THE Victoria branch of the Canadian Society of Civil Engineers recently presented the statement reproduced below to the Executive Council of the Government of British Columbia and backed it up by a considerable deputation. It will be noted that this is along the line that many engineers are thinking at the present time. They express their earnest desire to place their technical knowledge at the service of the government, particularly in this time of stress. They also register their disapproval of the appointment of alien civil engineers on public works—a practice that has been followed to a very considerable extent in the past. It is pointed out that no civil engineers are employed on the government undertakings in the United States unless they are citizens of that country. The statement is signed by Mr. D. O. Lewis, Mem. C.S.C.E., Mem. I.C.E., chairman of the Victoria branch, and Mr. R. W. Macintyre, Mem. C.S.C.E., Mem. Am.S.C.E., secretary, and is as follows:

"This deputation represents the Victoria and Vancouver branches of the Canadian Society of Civil Engineers, incorporated by a Dominion charter in 1887, and embracing in its membership practically all the qualified engineers in the Dominion of Canada.

"In addition to the object of promoting the acquisition of engineering knowledge, it is the purpose of this society to be an insurance of professional efficiency and an aid to our country in the successful achievement of its public undertakings.

"With this object, and having in view the public works which your government will undertake in the future, we desire to place our knowledge at your service should you at any time require advice as to the ways and means to be adopted. We shall be glad also to furnish you with information as to the qualifications and capabilities of civil engineers applying for government positions, as we have a record of the engineering experience of all members.

"In Europe our profession enjoys the highest degree of honor and recognition, and in Great Britain no undertaking is considered until the Institution of Civil Engineers is consulted as to the means and methods employed. If the governing bodies of Canada would adopt such a course the result would not occasion regret, and we believe that when the honorable members of this executive realize the importance of this question they will readily welcome the co-operation of the society.

"We desire also to request that Canadian civil engineers be granted just recognition, and that alien civil engineers be not employed on public works as in the past. We do not wish to prevent alien civil engineers from practising in Canada, but believe that the public works of our country should be carried out by British subjects.

"No civil engineers are employed on the government undertakings of the United States unless they are citizens of that country."

Obtaining Research Data

PLANS are practically complete for sending out Questionnaire No. 3, which has been prepared by the Honorary Advisory Council for Scientific and Industrial Research. The object of this questionnaire is to take an inventory of the research equipment and needs of the several thousand industrial establishments throughout the Dominion. These are being approached individually so as better to insure the return of prompt and correct information.

The Advisory Council has called to its aid in this matter the technical societies of the Dominion, who have unanimously demonstrated their willingness to do everything possible to further the collection of this information. These organizations include the Canadian Society of Civil Engineers, the Canadian Manufacturers' Association, the Canadian Mining Institute, the Society of Chemical Industry and the Joint Committees of Technical Organizations recently formed in the various provinces.

The actual work of organization for collection has been placed in the hands of a central directing committee, of which Mr. R. A. Ross, member of the Advisory Council, is chairman, and which also includes one member each from the C.S.C.E., the Canadian Mining Institute, the Society of Chemical Industry, Canadian Manufacturers' Association, and the Joint Committee of Technical Organizations, Ontario Branch. This central committee has organized a general plan of division of territory and apportioned the work of distribution among the volunteer organizations according to the facilities which each possesses in the respective divisions. By this plan, British Columbia is being covered by the C. S. C. E. and the Canadian Mining Institute; Alberta, by the C. S. C. E. and the Canadian Mining Institute; Saskatchewan, by the C. S. C. E.; Manitoba, by the C. S. C. E.; Ontario, with the exception of a small section in the eastern portion, by the Joint Committee of Technical Organizations, Ontario Branch; this eastern portion is being handled by an Ottawa Joint Committee. Quebec will be covered by the C. S. C. E. and the Canadian Mining Institute; the Maritime Provinces, by the Joint Committee of Technical Organizations, Maritime Branch.

It is hoped that the members of these various organizations will hold themselves personally responsible for seeing that the manufacturers in their district are sufficiently interested to fill in the required information and return it promptly to the Advisory Council. It is presumed that engineers can assist in this way not only by using their personal influence, but by giving such information of a technical nature as may be useful in assisting the different manufacturers to prepare the information required. Technical men throughout the Dominion are urged to make this a matter for their personal and earnest attention. In so doing they will be performing a patriotic service to their country and be assisting materially in bringing our war to a successful and early issue.

The Pantages Theatre, Vancouver, B.C.

The Architectural and Constructional Details of One of the Largest and Most Complete Buildings of this Kind in the West—A Steel Frame Structure—Cantilevered Balcony

By Glen Morgan*

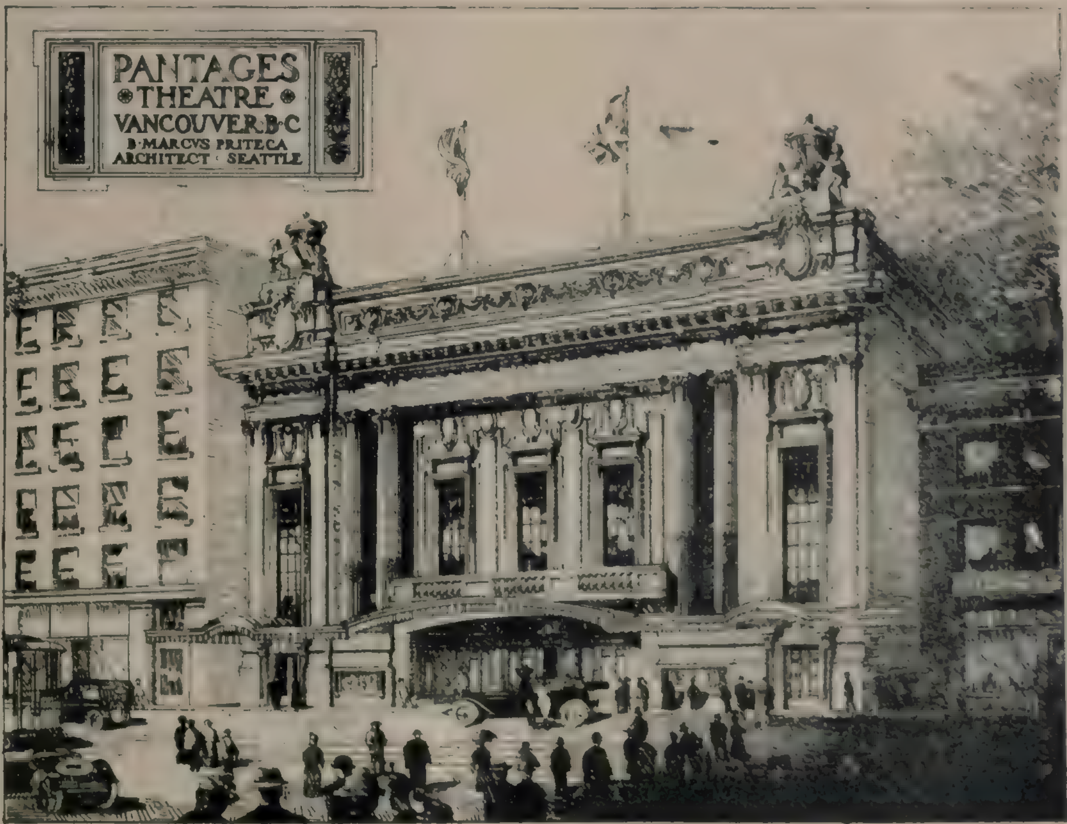
PROBABLY the most complete house in the Pantages vaudeville circuit, from the standpoint of architectural beauty and theatrical efficiency, is being built in Vancouver, B.C., by Mr. Pantages, at a cost of approximately $300,000. The seating capacity will be approximately 1,800. He has spared nothing in having all details worked out extensively to give every pleasing and efficient effect that might possibly be desired.

The front is about 100 feet long, having very imposing and majestic architectural treatment in ornamental terra cotta, following the French Renaissance style in design. In the lower portion there is an arched entrance and at either end is a doorway. There is a pavilion at each end over these, with pilasters, and a window opening. The centre portion consists of ornamented fluted Ionic columns and three window openings, in front of which is a small balcony. Over the windows are heavy cartouches. The whole is surmounted with a heavy cornice and richly ornamented parapet, with a large urn at each end. There is a copper marquee across the front, which follows the line of arches. Inside of the glass curtains of the marquee 75-watt nitrogen lights six inches apart will be used in giving a very strong light underneath and in the entrance lobby. Flood lights four feet apart will be placed over the marquee and played on the facade of the building. Concealed lights will be used in the sills of the windows and under the cornices, and exposed lights on top of the cornice and around the urns.

The floor of the entrance lobby will be tile of ornamental design, with a marble star in the centre. The walls will be of marble, the ceiling of ornamental plaster, and the doors of bronzed kalameen. The box office will be marble and ornamental iron, and will have ornamented canopy.

Architectural and Ornamental Features

The foyer is an arcade of ornamented domes, and on the auditorium side is treated with oak panelling and leaded glass. Stairs on either end lead down to a large smoking room, ladies' retiring room, and ushers' quarters. Two wide aisles and two side aisles lead off the foyer into the auditorium, which seats about 900, the seat banks being laid out radially, with an added increase in rise to each bank. Also from the foyer at either end are stairs leading to the mezzanine floor directly above. The ceiling here is alternately bowled and panelled, which runs into a cove that carries down under the balcony truss. An open space is thus left



The Pantages Theatre, Vancouver, as it will appear when completed.

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* Resident Superintendent of Construction.

over the back of the auditorium between the rail of the mezzanine floor and the balcony truss, which is valuable both from architectural and acoustical standpoints. The stairs from the foyer continue to the centre aisle of the balcony.

The balcony is about 60 feet deep, of cantilever construction, and laid out radially, the front rail being of 60 feet radius and the centre only about 35 feet from the stage. Below the centre aisle are five banks of seats and in front are the loge sections. The operator's booth is located in the extreme back of the balcony. Stairs from either the balcony or auditorium lead to three sets of both upper and lower boxes with connecting cloak rooms on either side of the auditorium. Two sets of double kalameen exit doors on either side of the balcony and auditorium open to courts between the theatre and adjoining buildings, where fire-escapes and walks are provided.

Period Decorations

The decorative treatment throughout the interior is of the Louis XVI. period, with wide panels and pilasters and latticed work in the upper wall portions. The proscenium opening is rectangular, 40 ft. x 30 ft. On either side of the proscenium is an Ionic column supporting the decorated entablature over the proscenium. The main ceiling is rectangular in plan, consisting of two heavy suspended coves—the lower one ornamented with heavy brackets, grilled panels and pilasters, and elaborate cartouches. There will be two sets of concealed cove lights, and also lights above an art glass drop in the centre.

All floor areas, stairways, boxes, and loges will be carpeted solid. Railings to boxes and loges will be upholstered with silk velour. All aisle entrances, box entrances, and glass panels back of auditorium will be draped with silk velour portiers. Brass railing will be used in loge divisions and along balcony main aisle. Stair balustrades will be of heavy ornamental cast iron.

Steel frame erected by guy derrick. Balcony carried on eight cantilever radials.

The stage is 30 ft. x 100 ft., with stage dressing room at one end and animal room at the other. The gridiron is 68 feet above the stage. A counterweight system is being installed for drops and border lights. At either end of the stage are stairs leading to the dressing rooms below. There are twelve of various sizes and one musicians' room. Each room is amply provided with slate shelves, mirrors, various mirror lights, and plugs for electrical appliances, and lavatory. Other rooms provide for tools, accessories, showers, ironing board, etc. Under the front of the auditorium are boiler, fan, and property rooms and plenum chamber.

Showing radial members that carry balcony.

Construction Methods

For the first ten feet of excavation sandy soil was removed by steam shovel, but from there down hardpan and an extremely tough, cemented conglomerate was encountered, and had to be entirely blasted out. Some ledges of granite formation were encountered, but were easily removed in comparison to aggregate. It was, therefore, no trouble to find sufficient bearing power for footings.

The frame of the building consisted of 325 tons of steel. This was designed by Mr. R. M. McCloy, of Seattle, Wash. Steel work was fabricated by J. Coughlan & Sons, Vancouver, B.C., and erected by the general contractors. An 80-foot mast was set on a bench 10 feet high in the centre of the building and guyed to the footings. A 70-foot boom from this, with a 30-foot extension, would reach the whole job. The balcony truss weighs 22 tons, spans 85 feet, and is 12 feet in length. It supports eight cantilever radials, of 62 feet to 75 feet lengths, which carry the concrete balcony slab. The truss was assembled on the job by laying the bottom chord first, filling in the diagonals, setting radials in place on seats in the truss, and then fitting in the top chord. The main roof truss spans 85 feet, and supports one end of each of three transverse trusses. The other ends of these trusses are carried by columns and the truss over the proscenium opening. Hangers and a box beam carry the brick wall from the proscenium opening up to the truss. The steel is fireproofed throughout, except where shut off by plaster, which plaster is backed with two inches of concrete, on top of the metal lath.

Reinforced concrete is used for walls under grade and all floors, roofs, etc. Floors under grade are laid by first running a 2-inch slab on earth, then membrane waterproofing; then, where below tide level, reinforced in the top slab. Banks for seats in the auditorium and balcony are reinforced concrete, with inserted sleepers for wood flooring and seat fastenings. The opening for the wood-constructed portion of the stage was used for sand and gravel hopper, and the skip for concrete was run up from the basement through the smoke-vent opening in the roof. Most of the concrete was deposited by chutes. This skip hoist was later used for hoisting brick to the upper part of the stage walls and roof.

The exterior walls are 13 inches thick, of brick laid up in cement mortar. There is also a brick wall of the same thickness between the stage and auditorium. A brick hoist built up from the plenum chamber to the auditorium roof allowed easy access to all scaffolds, and is now used for hoisting plaster casts, etc., for the heavy ornamented ceiling. All partitions are of structural tile. Metal lath is used throughout for plaster work. Side walls of the auditorium are furred out 18 inches, to allow for ventilation ducts. Metal-covered doors are used throughout, and the auditorium and foyer doors are bronzed kalameen.

Mechanical Equipment

For heating, two 690W Ideal smokeless boilers, provided with oil burners, are used to supply hot water for coils in the fan room and radiators on the stage.

Air from the fresh air intake is drawn through coils of 5,160 lineal feet of 1 inch pipe, through an air washer, and into a blower of 64,000 cubic feet per minute capacity, and forced through reheating coils of the same area as the others, into the plenum chamber, which is 17 x 30 feet. Air is then delivered at low velocity through concrete ducts under the auditorium slab, and enters the theatre from the orchestra pit, from grilles in the main aisles, back of the auditorium, back of the boxes, and through the grilled ceiling under the balcony; also from grilles in the steps of the balcony, and in the balcony walls. In the exhaust system two fans 22,000 cubic feet per minute in pent houses on the roof, pull foul air from the base around the auditorium, ceiling of mezzanine, front of boxes, and back ceiling of the balcony. All of the ventilating system is distributed through ducts, leaving no work to be taken care of in large spaces of furring. All ducts from the plenum chamber are thoroughly controlled by Johnson thermostats. The exhaust system is provided with a remote controlling device connected to switchboard at the stage, so that an adjustment of dampers will divert the different duct systems into roof ventilators, which, with two 42 inch ventilators over the auditorium convert the whole into a gravity system or allows flooding between consecutive shows. Two small exhausters take care of the retiring room and smoking room. Dressing rooms under the stage are ventilated by a fan, which exhausts four air into the vent about the boiler smokestack. A by-pass is here installed which will convert this portion into a gravity system when the stack is hot. All fans and motors are set on concrete foundations placed in sandbeds, and connections to housings are of canvas, to prevent vibration.

A vacuum system is being supplied from a stationary machine of reciprocating type to all parts of the theatre. An automatic sprinkler system is being installed, to take care of stage, gridiron, water curtain at procenium opening, and dressing rooms.

A circulating hot water system is to be used. There are two sewer levels. The lower one is subject to backing up on account of extreme high tides, and it was necessary to install a bypass into an automatic sewer ejector, which will be used at times of the year necessary. Barr & Anderson, Ltd., Vancouver, B.C., have the contract for installing all mechanical and plumbing work.

Electrical Equipment

Power supplied to the building will be approximately 65 h.p. for motors and about 110 kw. for lights. All lighting is indirect, and some very interesting effects are being obtained. Under the electrical work comes the intercommunicating telephone system,, buzzers, announcement panels, stage and house dimmers, speaking tubes, and fire alarm system. Electrical work is being installed by Mundy, Rowland Company, Vancouver, B.C.

Personnel

The architect for the theatre is Mr. B. Marcus Priteca, A.R.C.A., Seattle, Wash. Mechanical, sanitary, and electrical work was designed by Erwin L. Weber, consulting domestic engineer, Seattle, Wash. Construction is under the supervision of J. E. Gilbert, chief superintendent of construction, and the writer, resident superintendent. General contractors for the construction are Messrs. Skene & Christie, Vancouver, B.C.; R. T. Garrow, engineer, and R. Sharpe, superintendent.

A Definite Scheme of Road Organization

Essential for Success—Author Considers Commission Desirable—Separate Departments, Each with Engineer Head, if Work is Large

By George S. Henry, M.L.A.[*]

ORGANIZATION is an essential in the successful carrying out of any large undertaking, and efficient organization in road work produces results just as surely as in railroad work or commercial enterprises. Before we outline the organization which we consider suitable for road work we would like to interject that, much as we admire good organization, we are of the opinion that men of the proper type for the work they are undertaking are more essential than organization. Good men, men who know their work, although weak in organization but anxious to build roads, will accomplish better results than inexperienced, unambitious men, no matter how thorough their organization. Our conclusion, therefore, is, that in the organization which we will outline, good men must fill the positions to secure any real benefit from the organization.

We can readily see that it might be very difficult to outline an organization that would fit the conditions as found in different communities. We have, therefore, drafted a scheme of organization that to our mind appeals more particularly to the conditions applying in the Province of Ontario; and, should our scheme appear to have merit, we have no doubt that it can readily be adapted to the conditions prevailing elsewhere.

---

[*] Member of Toronto and York Highway Commission, before Canadian and International Good Roads Congress.

Getting Public Opinion Influenced

Although we deal with legislation first, it is readily understood that there must be a demand from the community for the legislation before the best results will be obtained. Preparatory to legislation, public discussion throughout the community will emphasize the advantages accruing from the construction of good roads. The expressions of opinion at such meetings will indicate to the legislature public feelings, and be a guide as to how far in advance of public opinion legislation can be introduced that will lead the community to support the movement rather than be antagonistic.

It is advisable that legislation should be uniform over large areas, so that there will not be the possibility of sectional jealousies and insinuations that certain areas are favored in the legislation. The first essential in a road organization is an attitude of mind of the community which indicates their belief that the laws they are operating under are equitable, and that they distribute fairly the reasonable costs of the undertaking.

Having secured legislation that provides the machinery for the construction of the roads and the assessing of costs, we come to the more direct question of road organization.

A Commission Desirable

The legislation being provided, we are of the opinion that the detail work should be under a commission, answering directly to the minister in charge of the Department of Highways. This highways commission might be charged with the oversight of all the highway schemes within the province to which the province contributes, and might act in an advisory capacity to smaller schemes. Their first duty would be to gather and assimilate information in reference to the various types of pavement now being used. Having acquired the information, they should then arrange such information as to be available for those road builders without the opportunity and experience necessary to digest such information. They could direct and advise the road builders in the smaller centres, and eliminate many of the expensive experiments in road-building which have and are now being carried out in too many localities. This commission could provide for the inspection of the provincial-aided work during construction and at completion, and undertake the road routine work of the department.

If provincial highways become a part of the good roads problem within any province, this commission, reporting to the minister, should be given charge of the location, construction, and maintenance of these provincial roads. Such a commission, composed of men familiar with large construction undertakings, would be in a position to consider not only the engineering features of the problem, but the commercial and economic advantages. Such a commission would, of course, be provided with a suitable staff of engineers, inspectors, and auditors.

County Organizations

In Ontario the chief organization for good road construction work so far has been the county, although at the present time a number of suburban areas are in contemplation which include urban and rural communities.

Again, we favor the commission idea, a commission answerable to the city and county councils which appoint them. We favor a small commision of not more than five members, and preferably men who have had municipal experience, familiar with the deliberate methods obtaining in municipal organizations. This commission should be appointed for a term of years, good conduct always being presupposed, for in this way alone can a definite policy be laid down and maintained, unless the officials, rather than the commission, become the dominant force. Commissioners appointed for a term of years will make a special study of the problem they are handling, and their experience obtained year by year makes for efficient work and organization. It is true that in a number of our counties good roads committees are appointed annually from among the representatives in the county councils, but the ever-changing personnel of the county councillors and the annual appeal of the county councillors for re-election tend toward a very unsettled policy in connection with the road work, for it has been found impossible to satisfy every area of the county in any one year.

Organization of a County Commission

The commission having been formed and given control of the construction and maintenance of the roads, the providing of the money still remaining in the hands of the legislative body, whether legislature, county council, or city council, the commission must proceed to organize its departments.

A secretary should be secured to receive the communications, record the minutes of the meetings, and forward such communications as the commision may direct. Where possible he should not hold any other position under the commission than that of secretary, although it may be necessary to secure a man at small salary who has another occupation. You will readily see the necessity of securing a secretary independent of the other officials. It is through this official that the board must receive written communications from outside bodies wishing to do business with the board, and it is sometimes necessary that these communications come directly to the board without permitting the interference of any other official. He should also certify that all accounts have been properly passed by the board and verified by the proper official.

Treasurer Can Help Prepare Cost Data

A treasurer should be appointed and bonded, whose duty it will be to collect the money authorized for expenditure and make all disbursements authorized by the board. The head of the treasury department should have a knowledge of bookkeeping and cost-keeping. It is essential that at the completion of the season's work a statement should be prepared showing the exact cost of each item of constructed work and tabulated with reference to roads, bridges, culverts, etc. A treasurer with a proper knowledge of bookkeeping can so work with the engineering department as to make the preparation of such a statement inexpensive and yet very informing.

An auditor should be appointed to check the treasurer's payments and vouchers and see that the same are properly authorized by the board, and the ideal auditor would be a man who could report directly to the board upon the methods adopted by the secretary and treasurer for the keeping of proper records, and, in addition, upon the purchases and costs as shown by the accounts from the engineering department.

The selection of a chief engineer is perhaps one of the most important appointments which such a commission would have to undertake. The engineer, acting under the direction of the commission, should be held responsible for the design, construction, and maintenance of every road or structure of which the commission has charge, together with control of all their employees, excepting those already mentioned.

If the work is large enough, the chief engineer may be able to form separate departments, with experienced men as heads of each department; but, as a rule, the work is not of that character, and it is in this situation that the larger provincial commission can give expert service to the road-builder who is not expert in the three departments which have been mentioned.

Designing, Constructing and Maintenance Engineers

Taking it for granted, however, that the work is large, and a designing engineer can be employed who can take charge of the office work and the design of bridges, roads, culverts, etc., it will be found that such a man will be best employed giving his full time to office work. The designs thus prepared under the direction of the chief engineer will then be turned over to the constructing engineer.

The constructing engineer should, under the chief engineer, have full control of all construction work, whether done by day labor or under contract. Experience has shown that a proper combination of day labor work and contracting will give the best results. The day labor gangs, under the constructing engineer, act as a brake on excessive profits by contractors, and the contractors constructing similar works are a splendid check on excessive costs by day labor, and it is in this connection that an efficient treasurer can show up concisely the costs under both methods. The number of gangs employed will depend upon the amount of work undertaken, but it will usually be found that an experienced foreman can do efficient work with gangs of from twelve to eighteen men.

The maintenace engineer should have charge of all roads and structures as soon as the construction department is relieved of them by the chief engineer. As a rule, the construction department should not be relieved from the responsibility of new work for at least six months after completion. If immediately upon completion a department is relieved of responsibility, it will be found that certain essential details will be consistently skipped.

Patrol System Most Effective

Maintenance work is not so spectacular, nor does it appeal so effectively to the community as construction work, and it is therefore frequently overlooked; but it is nevertheless one of the most important departments of road work.

The patrol system under a maintenance engineer is, without doubt, the most efficient and finally the most inexpensive method that can be adopted. The length of the patrol will vary with local conditions, and the expenditure per mile will depend upon construction costs and traffic carried. One of our most efficient patrol gangs handles some thirty miles of road, but they live at the intersection of two main highways, and are provided with a light motor truck, so that the extreme end of their beat is only some twenty minutes from their homes. By making the beats large and working two or three men together, it found that the men take greater interest in the work, and thereby accomplish more in a given time. One man working alone soon develops a very slow gait, and is without incentive to quicken his work. Where conditions are not suited to such a large organization, two men working in the centre of a seven-mile beat, with one horse and a wagon, can patrol the section, and, in addition, do a certain amount of construction work.

Where it is not possible to have three engineers, one for each of the departments mentioned, it will be necessary for the chief engineer to take charge of each department, having where possible a superintendent who can carefully inspect the field work, and, where necessary, give directions to the foremen.

Suitable Foremen Hard to Obtain

Because road work is new in Canada foremen suitable for rural, or even interurban, road work work are difficult to secure. We have a large body of men trained for work in cities where there is every convenience of tools, machinery, and special equipment, but a foreman for road work such as we are interested in should be of a different type. He should be not only able to handle men and do ordinary road building, but in addition should be able to make use of every natural condition that surrounds his work. A cross between the "buck beaver" of the lumber camp and the "walking boss" of the railroad gang.

Commence the work with few outfits and train your men, and the next year you will be able to double your gangs by using these trained men. If there is much concrete work, organize a special crew for this work, making sure you have one man who can build and place forms.

Results of This Organization

The organization outlined may not be ideal, but it lends itself most readily to ordinary conditions, and will make for efficiency in construction and management with even the most ordinary engineers or road superintendents; and, while it is quite clear that good roads have been built cheaply with an organization much simpler than the one outlined, it is also evident that their work has been in the nature of costly experiments, and the good roads movement has suffered accordingly.

I am persuaded that the organization outlined will lead to: 1. Continuity of plan. 2. Permanency of organization. 3. Elimination of friction. 4. Efficient, cheap construction. 5. Constant and systematic maintenance. 6. The minimum of overhead expense. 7. A community satisfied that good roads are a permanent investment, not an expense.

Railway Commission's Report

Experts Not Unanimous—Nationalization of Canadian Railways Recommended in Majority Report

THE Royal Commission appointed by the government to report on the general problem of transportation in Canada has just made public its findings and recommendations. This commission, which is composed of Sir Henry Drayton, Chief Commissioner of the Canadian Board of Railway Commissioners, W. M. Acworth, of England, a well-known authority on railway rates and economics, and A. H. Smith, president of the New York Central Lines, was not unanimous in its findings. The majority report, prepared by the first two named members of the commission, covering 90 pages of closely printed matter, suggests a comprehensive plan for the solution of the Dominion's difficult railway problem. Mr. Smith does not concur in the judgment of his fellow-commissioners, and has prepared a minority report setting forth his grounds of dissent.

The majority report, in brief, recommends the immediate nationalization of the Grand Trunk, Grand Trunk Pacific and Canadian Northern, with the National Transcontinental and Intercolonial, into one great publicly-owned system operated by an independent board of five commissioners on a strictly business and economic basis free from the danger of all political interference. The Canadian Pacific is to be maintained as a private enterprise competing with the publicly-owned system, but both under the control, as to rates, of the Dominion Railway Board, both operated by expert railway men, both serving their own economic territories, competing with each other but each serving the people who contributed nearly all the financial assistance which built them.

The report includes details of the organization of the managing commission and the requirements to eliminate political interference so that the proposed new national system may be operated on a strictly commercial basis and be placed, within a comparatively short period of time, upon a satisfactory financial basis.

The American railroad expert, Mr. Smith, is opposed to government ownership and operation, believing that the best results can be achieved by continuing private enterprise, with the re-organization and the better co-ordination of the work of the Grand Trunk Pacific, the Grand Trunk, National Transcontinental and Canadian Northern.

He recommends in brief, the taking over of the Grand Trunk Pacific with its branch lines in the West by the Canadian Northern, leaving the latter company free to operate in the western part of Canada, while the Grand Trunk should lease the eastern lines of the Canadian Northern from North Bay east, and confine its operations to eastern Canada. With regard to the Intercolonial and National Transcontinental, he believes that they should be left as at present, as a continuous system from seaboard to the grain-distributing centres.

The Commissioners agree that the Canadian Pacific is now giving good service and should not be interfered with. The Commissioners also agree that present conditions are economically bad, that there is wasteful duplication of lines, lack of co-ordinated transportation economy, and heavy deficits to be met on behalf of the railways by the people of Canada for years to come, unless some scheme of radical reorganization is promptly carried out.

Successful Engineering Graduates at McGill

The following are successful candidates for the degree of bachelor of science, announced by McGill University:

Civil Engineering (in order of merit) — Boast, Chester Winfield, Richmond, P.Q.; Gardner, William McGregor, Montreal; Poe, Alexander Spence, Montreal; Hooper, Benjamin Reagh, Charlottetown, P.E.I.; Aggiman, Jacques, Constantinople, Turkey; Heartz, Richard Edgar, Marshfield, P.E.I.; McCulloch, Orval James, Ottawa; Mackenzie, William Langlands, Ottawa; Turnbull, Lawrence Russell, Dockton, D.C., U.S.A.; Trudeau, Alphonse, Montreal; Carroll, George Francis, Montreal.

Unranked (in alphabetical order)—Alberta, Albert Miller, Jamaica, B.W.I.; Milne, Arthur Hartley, Montreal West; Wicenden, Henri Robert, Bethel, Conn.

Unranked, on military service (in alphabetical order)—Fraser, William Lawrence, New Glasgow, N.S.; Peace, William J. Bartonville, Ont.; Richardson, Samuel Sparling, Notre Dame de Grace; Scott, George M., Westmount.

Mechanical Engineering (in order of merit)—Weldon, Richard Laurence, Winnipeg; Ross-Ross, Donald Ronald de Courcy, Lancaster, Ont.; Murphy, Albert Edward, Arnprior, Ont.; LaPrairie, Charles Leonard Richard, Montreal.

Unranked—Chisholm, Arthur, Harold, Ottawa.

Unranked (on military service)—Clark, Allan Lindsay, Victoria, B.C.; Derrer, Louis Henry, Sault Ste. Marie, Ont.

Degree of Bachelor of Architecture—Labelle, Henri Sicotte, Westmount.

Prizes and Honors in Science

Honors in the graduating class of the faculty of applied science, presentation of medals, certificates, and prizes are as follows (names in alphabetical order)—Aggiman, Jasques, Greenshields' prize for summer essay, honors in theory of structures; Boast, Chester Winfield, British Association medal, honors in geodesy, hydraulics, strength of materials, and theory of structures; Clough, Roy Brainerd, prize for summer essay, second prize for paper read before the undergraduates' society for applied science; Kert, David, British Association medal, honors in inorganic quantitative analysis and physical chemistry; Poe, Alexander Spence, honors in theory of structures; Ross-Ross, Donald Ronald de Courcy, Crosby Steam Gauge and Valve Company's prize for summer essay, first prize for paper read before the Undergraduates' Society of Applied Science; Weldon, Richard Lawrence, British Association medal, honors in mechanics of machines, works organization, and manufacturing plant design.

Montreal's New Building By-laws Overdue

The long-overdue new code of building by-laws of Montreal was the subject of representations to the Board of Control by members of the Builders' Exchange, Canadian Society of Civil Engineers, and Province of Quebec Association of Architects. These gentlemen interviewed the Board of Control on May 4. Mr. Hugh Vallance, president of the Architects' Association, introduced the deputation, the speakers being Mr. Walter J. Francis, of the C.S.C.E.; Mr. J. P. Anglin, president of the Builders' Exchange; Mr. Joseph Venne, past president of the Architects' Association, and Mr. M. Beullac, of the Builders' Exchange, who represented the steel interests.

The new code, it appeared from the statements, was ordered to be drafted seven years ago; the matter was handed over to a committee of the various bodies interested, and in turn the drawing up of a draft was entrusted to Mr. Francis and Mr. Venne. The report was finished in 1913, and since then the matter has been in the hands of the city. The code has been referred to the law and other departments, but has not been adopted by the Council. The deputation were anxious that the code, which is a great improvement on the one now existing, should be put into operation without further delay. This was in the interests of fire protection and the general well-being of the building trade.

Mr. Laurendeau, the city attorney, stated that one reason for the delay was the new plumbing and heating by-laws, which have yet to be adopted. The feeling of the Builders' Exchange is that, if necessary, these by-laws should be made into a separate code, so that the other building by-laws can be adopted.

Mayor Martin suggested that the civic committee which had the matter in hand was responsible for the want of action, and promised to bring the question before the Council with a view to meeting the wishes of the deputation.

Timber Decay and Its Growing Importance to the Engineer and Architect

By C. J. Humphrey[*]

TO the structural engineer and architect the subject of timber decay is becoming of ever-increasing importance, due largely to the fact that the timbers which have entered into the construction of many important buildings during the past decade or two have failed to give the service expected of them.

It is a matter of common knowledge that this unsatisfactory record of service is primarily the result of using timber inferior in its resistance to decay; however, there also enter into the question in certain instances, very obvious errors in design and construction. In the earlier days, when a larger percentage of high grade structural timbers was available, delinquencies in construction did not result so disastrously and, hence, attracted much less attention from members of the engineering profession.

What Causes Decay?

Before entering the discussion further it may be well to outline to you briefly the causes of decay and the environmental factors which promote it. Decay is due almost entirely to the growth of wood-destroying fungi within the tissues of the wood. There are many hundreds of different fungi which disintegrate wood in the forest, but the greater part of the economic losses in structural timber is referable to a comparatively few species.

These fungi are plants just as much as are trees and herbs. They differ merely in their form, lack of green coloring matter and methods of nutrition. While green plants absorb their food supplies from the soil through their roots, fungi derive their nutriment from the substance of the wood.

In the life-cycle of a wood-destroying fungus there are two distinct stages: (1) The vegetative stage, consisting of thread-like, usually much branched, filaments, termed mycelium; (2) the fruiting stage, which is nothing more than a compact mass of mycelium which takes on a definite form on the surface of the decaying timbers and serves for the production of spores and, hence, the propagation of the species.

Usually mycelium is confined within the wood substance, the fine cotton-like filaments ramifying throughout the tissues and filling the pores of the wood and the cells of the pith rays, as well as boring through the walls of the wood elements. It can roughly be compared to the root system of ordinary plants for its function is the same, namely, that of an absorbing system.

Conditions Essential to Mycelian Growth

In addition to available food supplies derived from the wood constituents through organic action, fungi require certain essential conditions for their development. These are: 1, sufficient moisture; 2, at least a small amount of air within the wood; and 3, a suitable temperature.

A suitable amount of moisture is, without doubt, the most important factor in decay. The different wood-destroying fungi appear to have their own particular minimum necessary to fulfil growth requirements. Certain ones classified as "dry rot" organisms seem to get along on a comparatively small amount, while others thrive only in highly humid surroundings. In the case of "dry rot" fungi it appears to be more a question of the ability of the organism to tolerate dry conditions, or to produce their own moisture from the wood than any essential need for such conditions, for observations and laboratory tests demonstrate that an increase in the moisture under such circumstances leads to more rapid decay.

The need for at least a certain minimum of water is well shown under practical conditions. The points of failure in ordinary dry buildings are the points at which a little extra water is brought to, or held within, the timbers; for example, the ends of joists or girders set in brick or concrete walls, outer window casings, wood surrounding water pipes which may sweat or occasionally burst, porch floors and ceilings and other exposed trimmings where atmospheric moisture may collect at the joints, and last and often most important, basement timbers, either in contact with or close to moist soil.

Most people are familiar with the way in which posts and telephone poles rot at or near the ground line. Below the ground line the sapwood completely decays, while above the ground line a thin shell of dry hard outer wood remains, with the decay running up beneath it. This is entirely a result of moisture conditions. The same phenomenon often occurs in water tank staves where the outer face is too dry and the inner face too wet to decay, while an intermediate zone may completely disintegrate.

Air Absolutely Necessary

A certain amount of air within the wood is absolutely necessary for decay. The organisms need it for their growth. In saturated wood, the air is, for the most part, displaced by water and fungus growth is impossible.

The very widespread idea that decay is due to alternate wet and dry conditions has developed through observation of the way timbers behave when exposed to the elements. Take, for instance, a railway tie partly embedded in soil. During a dry season it may dry out to such an extent that decay is very slow, then come the rains, and if only sufficient water falls to put the tie in a good moisture condition it begins to rot rapidly again, and will continue to do so as long as the moisture and temperature are favorable. If, on the other hand, there is a long-continued rainy period, the tie may soon become saturated and decay will stop again and remain practically at a standstill until the stick dries out sufficiently to admit the necessary amount of air. Thus, in the alternation of wet and dry conditions, one gets at some points intermediate between the dry and wet ranges a condition at which decay is at its maximum. If the timber were maintained at this optimum point, decay of the stick would be at its greatest and the alternating wet and dry conditions would be unfavorable. It is only under fluctuating natural conditions that alternation becomes of advantage.

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The third essential condition for rapid fungous growth is a suitable temperature. For the majority of species the most favorable temperature lies between 75 and 85 degrees Fahr.

The fact that all the species of fungi occurring naturally in a given locality can withstand the most severe winter weather shows their extreme hardiness to low temperatures. While growth may be almost completely suspended under these circumstances, the organisms will normally recover their growth capacity soon after being placed under more favorable conditions.

As a rule, light exerts a retarding effect on mycelial growth. This may amount to as much as an 18 per cent. reduction.

Vitality of Mycelium

Mycelium in wood is often very long-lived in timber dried in the air at moderate temperatures. Once it gets well distributed throughout the wood, it is doubtful, in very many cases, whether the wood can again become free of infection as a result of natural atmospheric conditions. One case on record shows that a stick infected with one of our common species contained very vigorous mycelium after having been kept in a warm dry room for four years.

Fruiting-Bodies

The second stage in the life-cycle of a wood-destroying fungus consists in brackets or shelves, "toadstools," or often only compact incrustations which appear on the surface of the timber after decay has become well started. Their function is to produce spores, which are comparable to the seeds of ordinary green plants. Being very minute (finer than flour) these spores are readily carried about by air currents and lodging on the surface of moist timber, at a favorable temperature, germinate to produce new infections.

A large part of the infection of timbers in the open occurs through the agency of these spores, but in buildings, where fruit-bodies are less likely to develop, they play a less important role.

Decay in Building Timbers

Having now briefly reviewed the conditions which favor the development of rot-producing fungi, I will cite a few specific instances of the more serious fungus outbreaks which have come to my personal attention. All of these cases could readily have been prevented had the men in charge of the design and construction been familiar with the fundamental conditions which invariably lead to rapid decay.

The principal sources of danger fall, roughly, under the six following heads:

(1) Placing non-durable timber in moist, ill-ventilated basements or enclosures beneath the first floor, or laying sills in direct contact with the ground.

(2) Embedding the girders and joists in brick or concrete without boxing the ends.

(3) Placing laminated flooring in unheated buildings in a green or wet condition.

(4) Covering girders, posts or laminated flooring with plaster or similar coating before thoroughly dried.

(5) General use of non-durable grades of timber in a green or only partially seasoned condition.

(6) Use of even dry timber of low natural durability in buildings artificially humidified to a high degree, as in textile mills.

A further element of danger lies in the use of timber infected during storage, or which has become infected through neglect after purchase and delivery.

Poor Ventilation in Basements

A considerable number of cases where poor ventilation beneath buildings, principally warehouses and frame structures, has started serious infections have come to the writer's notice. One case will suffice for illustration. This was a wholesale carpet and rug warehouse in a city on the Pacific Coast. It was a one-storey frame building four and one-half years old, with solid concrete foundations, except for four small screened ventilators in front about 5 inches by 18 inches in size. The building was set about two feet above the ground and the air beneath the floor was stagnant and very humid, especially at the back end, where the infection started. In the course of about three years the fungus had rotted out a portion of the floor girders, joists and flooring, and had done some injury to stored rugs. At this time repairs were made beneath the floor and also a new floor was laid on top of the old one. In less than a year the new floor and also the bottom of racks resting on it were badly rotted, causing further injury to the carpet and rug stock. In one case the fungus passed through the floor, the base of a rack about one inch off the floor, and twelve thicknesses of heavy rugs, eating large holes in them.

Embedding Timbers in Brick or Concerte

Cases where girders and joists embedded in brick or concrete walls have rotted off in a short period of time are not uncommon. The writer has investigated one case on the Pacific Coast with considerable care. This was an unheated mill-constructed building used as a hardware warehouse. Heavy 12 by 20 Douglas fir girders, in a green condition, had been covered tightly with light galvanized iron at the ends and then embedded for about 18 inches, without boxing, in concrete pillars at the outer walls. In about four and one-half years many of the timbers were thoroughly rotted at the ends and had to be removed. In an effort to control the rot, the concrete has been chipped away from the ends of the girders to allow them to dry. Borings taken in May, 1916 (after chipping away the concrete), in two girders between the depths of 4 and 6 inches, show the following moisture percentages: 1 foot from end, 19-20 per cent.; 2 feet from end, 14-16 per cent.; 5 feet from end, 11-13 per cent.

It is thus seen that the timbers were then in an air-dry condition at 5 feet from the ends. Very little, if any, rot has developed at these points.

Laminated Flooring

There seems to be some divergence of opinion regarding the use of laminated floorings. In many buildings it has proven completely satisfactory. In others it has given very poor service. All the complaints investigated by the writer have shown the trouble to be due to the use of wet material. This, at best, dries very slowly in an unheated building. Covering such timber with plaster, or any other heavy coating, when moist will almost invariably cause trouble. If difficulties with laminated flooring are to be avoided, the timbers will have to be thoroughly air seasoned and kept dry during construction.

Covering Timbers

This leads us to a consideration of the advisability of covering materials in mill-constructed buildings. A number of cases already investigated indicate clearly that the practice should not be recommended except with extreme caution, and a close knowledge of the condition of the timber as it goes into the building. I will cite but one case. This occurred in a mill-constructed building in Chicago. This building was erected about three years ago, the construction being under way throughout the winter, so that the timbers were subject to periodic wetting from rains and snow. Such timbers as I have seen removed from the building on account of decay were, for the most part, of poor quality, low density, mostly rapid growth, very knotty and often with a large proportion of sapwood. Of eight girders and posts which were identified for species, seven proved to be loblolly pine and one shortleaf.

Laminated floors of mixed quality, usually sappy and wide-ringed southern pine, scant 3 by 6, were laid throughout the building, with the ends resting directly on the girders, with about a 6-inch bearing. The ceiling, girders and posts were all encased in plaster board, leaving a narrow air space between the board and timbers.

This combination of circumstances—low quality timber, high moisture content, and plaster board covering—caused the timber to rot rapidly, particularly at the bearings of the laminated floor on the girders.

At the time the writer inspected the building the timbers had reached an air-dry condition for a heated building and the fugus was apparently dead except on the top (seventh) floor. During the time in which the timbers were drying to this point, however, the fungus had ample opportunity to produce serious decay in many of the timbers which resulted in the removal of a considerable number.

How to Control Decay

This phase of the subject can best be discussed under two main heads: 1, Prevention; 2, Eradication.

Prevention of Infection.—The possibility that timber may reach the consumer with infection already in it is by no means remote. Many lumber yards are in a highly unsanitary condition as regards the presence of destructive fungi. For this reason the material should be carefully inspected and all pieces bearing incipient rot rejected. Likewise, it may prove advisable to inspect the yard where the purchase is made.

Upon delivery of the material it should not be thrown about on the ground, but should carefully be placed on skids and kept dry. The soil is often a prolific source of infection.

Such timbers as are to be placed in situations favorable to decay should either be select grades of naturally durable stock or else treated with a good wood preservative. Neither non-durable timber nor sapwood is objectionable when used in a dry condition and kept dry. Hence, every effort should be made during construction to keep moisture away from the timbers, and especially the joints.

Moist timbers should never be cased in, nor should timber of any sort be embedded in concrete or brick walls without boxing.

In all cases thorough ventilation of moist, stagnant basements should be provided.

Eradication of Infections

Whenever timbers begin to fail, the need of a thorough inspection of the building is indicated. If poor ventilation is the cause, the building should be opened up to secure rapid drying of the timbers. At the same time tests should be made to determine whether the wood contains living fungus. It is also important to know what species the fungus is, as further control measures may hinge on its identity. For instance, the true dry-rot fungus, being a low-temperature organism, can be controlled by the application of heat, while such a procedure would be useless with most other species. Some fungi may also prove susceptible to a certain amount of drying, where others would not.

Where serious and active decay exists, without the exact method of control being indicated, the timbers should be carefully removed and replaced with select durable stock or with lower grade material treated with antiseptics. Likewise all incipient infection which appears in timbers which it is not considered necessary to remove should be given two or three applications of a wood preservative. Either a hot 3 to 4 per cent. water solution of sodium fluoride or a cold 1 per cent. alcoholic solution of mercuric chloride is well suited to interior timbers. Exterior timbers, where odor and color are not objectionable, can be satisfactorily treated with a good grade of hot coal tar creosote.

Cement Concrete Roadways of Ontario

A Detailed Schedule of All Pavements of This Type Laid in the Province — Over 1,500,000 Square Yards

By T. Harry Jones*

THE following schedule, prepared as an appendix to a paper read by the writer at the Canadian and International Good Roads Congress, abstracted in the Contract Record of April 18, gives statistics covering the cement concrete pavements laid in the Province of Ontario. Under an alphabetical arrangement of municipalities the following data on this kind of road is listed: Amount and type, mix, nature of reinforcement, joints, mode of construction, present condition. The total amount of concrete roads in Ontario is now well over one-and-half million square yards.

Aylmer

Total number of square yards of one course, 6,681. This was the model road constructed by the Ontario Highways Department in 1914 on Talbot Street, one of the leading entrances to the town, and on the main highway from Windsor to Niagara Falls. One course, 7 in. thick; 1,918½ ft. long; 30 ft. wide between curbs; mix, 1 of cement (of which 10 per cent. by weight is hydrated lime) to 4 washed lake gravel; steel reinforcement; transverse joints every 30 ft. and longitudinal joints next curb.

Total number of square yards of two course, 24,336; average cost, $1.49, including Baker joints, which cost 9c per square yard; base, 5 in., using mix 1:4 (pit gravel); top, 2 in., using mix 1:1½:3; all pavements reinforced.

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* City Engineer, Brantford, Ontario.

The first section was laid in 1913, on a residential street, the main road to the station, and carries heavy traffic. It is 28 ft. wide, 7 in. thick, with reinforced ½ in. joints at curb. In 1915 a 5 in. concrete top was laid by contractor on old surface. For 14 inches from curb to about 5 ft. from curb the existing surface was picked to a depth of 3 in., and holes that had developed dug out to a depth of 7 in. Concrete 5 in. thick was laid from a point 14 in. from curb over whole surface, mix 1:2:4. Steel reinforcing used, with transverse joints every 30 ft., filled with prepared felt.

First concrete pavement laid in 1913.

Barrie

Total number of square yards of one course, 14,850; thickness, 6 in.; mix, 1:2:4; no reinforcement used. Ninety per cent. of blocks are free from cracks or ones not requiring repairs. Except for 250 ft. over a creek, where subgrade settled, Tarvia was used in expansion joints and a few large cracks. The pavement has been entirely satisfactory.

Brantford

Total number of square yards of one course, 2,626.

The first concrete pavement was laid in 1910, on Lorne Crescent, a residential street; one course; length, 394 ft; width, 24 ft.; depth, 6 in.; mix, 1 to 6 of pit gravel; transverse joints every 30 ft., filled with pitch; others with wood strips, and a few with neat cement. Longitudinal cracks have developed, pavement having been laid late in the year and caught by frost. Cost, 80c per square yard. No repairs have been necessary.

Another one-course pavement laid in 1911 on Chestnut Avenue; length, 535 ft.; width, 26 ft; depth, 5 in.; mix, 1 to 5 of crushed gravel. This is a residential street, but subject to heavy teaming. Grade from 1 per cent. to 5 per cent. Joints made by pine strips, ¼ in. wide at top and at bottom to full depth of pavement. A longitudinal joint left in centre for a length of 110 ft. Longitudinal cracks have developed, excepting in the part where longitudinal joint was left. No repairs necessary.

Total number of square yards of two course, 10,779.

A two-course pavement laid on Market Street in 1912; length, 200 ft.; width, curb to curb, 40 ft.; grade from 5 per cent. to 8 per cent. Subject to the heaviest traffic in the city. Base, 4 in., with mix 1 to 4 of gravel and broken stone; top, 2 in., with mix 1 to 1½ coarse sand; corrugations, ½ in. deep, left every 4 in. at right angles to the street; no joints. Very few cracks, except in lower section, where a 30 ft. excavation had been made. No repair necessary other than re-cutting the corrugations. Cost, $1.25 per square yard.

Park Avenue.—In 1914 a pavement was laid on this residential street, which is subject to heavy teaming. It is 1,532 ft. in length and 27 ft. wide, with a 5 in. crown. This was a two-course pavement. Depth, 7 in.; bottom course, 5 in., composed of 1 part of cement to 4 parts of bank gravel; the top 2 inches was 1 of cement to 1½ of a coarse sand. Transverse joints left every 30 ft. One-half the width of the pavement for its full length was first constructed; the other half joining it was constructed without any filler between. This pavement has given good satisfaction; only two or three cracks have developed, and these owing to local conditions. It has cost nothing to repair. Cost, $1.30.

Erie Avenue Pavement.—This pavement was begun in 1915. Its length is 3,200 ft., of which 1,350 ft. have been completed; concrete curb and gutter put in before pavement was laid. A single track is laid down the centre of the street. Width from curb to curb, 36 ft.; sub-foundation, gravel; between ties, one-course concrete, 6 in. deep, 1 to 6 of pit gravel; above ties and between rails one course 1 to 3½ of pit gravel; cross joints every 11 ft.; from rails to water table two-course pavement, 11 in. deep at rail and 9 in. at water table; bottom course, 1 to 4 of pit gravel; top course, 2 in., 1 to 1½ of coarse sand; in bottom course 1½ in. of sand between slabs; joint for top cut through and groover run across; transverse joints left every 33 ft. Cost per square yard, $1.55, of which 46 per cent. was for material.

Chatham

Total number of square yards of two-course, 50,000, of which 19,000 square yards were laid in 1916. Base, 3½ in., with mix 1:4; top, 2½ in., with mix 1:3. Average cost, including grading, $1.30. Reinforcement used in all pavements, except about 2,000 square yards. All pavements giving perfect satisfaction, except one strip 900 ft. long, laid in 1915. The pavement laid in 1908 was not reinforced, and is in good condition.

First concrete pavement laid in 1908. Pavements laid on business and residential streets.

Dunnville

Total number of square yards of one-course, 11,833. Thickness, 6 in.; mix, 1:2:4; no reinforcement used. Eighty per cent. free from cracks in 1915. A few holes developed by 1915, but most of it in good condition. Most of it resurfaced 2 in. with Tarvia, at cost of 35c per square yard, the pavement having been laid with intention of resurfacing.

First concrete pavement laid in 1912, used on business and residential streets.

Grimsby

Total number of square yards of one-course, 17,500. Thickness, 6 in. to 8 in.; mix, 1:2:3; average cost, 84c; no reinforcement used. The road has given every satisfaction. While cracks show on minute examination on 50 per cent. of blocks, no crack is serious or requires attention, and in no way affects the road. Low cost, partly owing to sand and gravel obtained for cost of hauling, at 65c per cubic yard. This pavement laid in 1916.

Ingersoll

Total number of square yards of one-course laid to end of 1915, 4,100; laid on semi-business and residential streets. Depth, 7 in.; mix, 1:1½:3, crushed stone; cost, $1.35, or $1.50 where extra grading required.

In 1916 number of square yards laid, 11,122.

Jarvis

Total number of square yards of one course, 14,000; thickness, 7 in. at centre, 5 in. at sides; mix, 1:2:3, stone; except in about 300 square yards, no reinforcement was used. Twenty-five per cent. of the blocks free from cracks; cracks are attributable to excessive heat and dryness of 1916 and foundation not having been thoroughly consolidated.

First concrete pavement laid in 1914.

Kitchener

Total number of square yards of one-course, 600; thickness, 7 in.; mix, 1:1½:3, screened gravel; average cost, $1.48.

Total number of square yards of two-course, 9,100;

base, 5 in.; mix, 1:2:4, screened gravel; top, 2 in.; mix, 1:1½:3, stone; average cost, $1.50. Number of square yards laid in 1916 of two-course, 6,040. All the two-course work is reinforced, and 99 per cent. of the blocks are free from cracks.

First concrete pavement laid in 1914; used on business and residential streets.

Kemptville

Total number of square yards of one-course, 1,682; thickness, 7 in.; mix, 1:2:3; no reinforcement used.

First concrete pavement laid in 1913.

Leamington

Total number of square yards of one-course, 36,935; thickness, 6½ in.; mix, 1:1½:3, gravel or stone; average cost, $1.27; number of square yards laid in 1916, 25,735; same as above; average cost, $1.25. All pavement reinforced; 99 per cent. of the blocks free from cracks; specifications same as Wayne County.

First concrete pavement laid in 1915; laid on business and residential streets.

London

Total number of square yards of one-course, 19,673; thickness, 5½ in. at side, 7½ at crown (1913-14), 9 in. (1915-16); mix, 1:4½, gravel; average cost, $1.60. Number of square yards laid in 1916, one-course, 4,420; average cost, $1.66. All pavement reinforced; 24 ft. wide; laid on 4 in. gravel sub-base; crown, 5 in; longitudinal joint of ¼ in. elastite between gutter and curb; cross joints of Armor plates and ¼ in. elastite 40 ft. to 50 ft. apart. Heavy clay subsoil; tile under curb; closed to traffic three weeks. Cost includes grading (average 18 in.), sub-base, reinforcing, and expansion joints.

First concrete pavement laid in 1913.

New Hamburg

Total number of square yards of two-course, 8,000; base, 5 in.; mix, 1:2:4; top, 2 in.; mix, 1:1½:3; reinforcement used. Average cost, $1.41, including grading and engineering. This pavement laid in 1916.

Niagara Falls

Total number of square yards of one-course, 9,800. In 1913 there were laid 6,500 square yards. Seven in. thick; 1:2:4 mix; no reinforcement; cost about $1.47.

In 1915 there were laid 3,300 square yards; width of roadway, 24 ft.; thickness, 6 in. at sides, 8 in. at centre; mix, 1:2:3; reinforced with No. 20 Kahn mesh. Expansion joints 35 ft. to 45 ft. apart; ½ in. joints at curb. Cost, $1.40, exclusive of engineering, inspection, interest, etc., amounting to 24 per cent. No transverse cracks; 50 per cent. of blocks show slight longitudinal crack near centre, which has not opened up.

First concrete pavement laid in 1913.

Oshawa

Total number of square yards to end of 1915, 26,375, located on business streets, all one-course; thickness, 5 in. at side and 7 in. at centre; mix, 1:2:4; majority 16 ft. to 18 ft. wide; average cost, including grading, 90c. No reinforcement used. Cost per square yard in 1915, $1 (gravel and sand furnished by town at 10c per load); work let by contract, and guaranteed for two years.

First concrete pavement laid in 1913. Number of square yards laid in 1916, 3,111.

Peterboro

Total number of square yards of one-course, 975; pavement laid in 1912, 403½ ft. x 21 ft. 9 in.; mix, 1:5, pit-run gravel; ½ in. expansion joint in centre at curb and every 25 ft. Cost, 97¾c, no charge for gravel-hauling included.

(To be continued.)

Why Cement Costs More

THIS comment on the higher price of cement comes from the Portland Cement Association: In connection with the advance in the prices of building materials in the last two years, information reaches the public occasionally which indicates that the manufacturer in dealing with labor and raw materials has the vexing problem of high prices before him quite as well as the consumer.

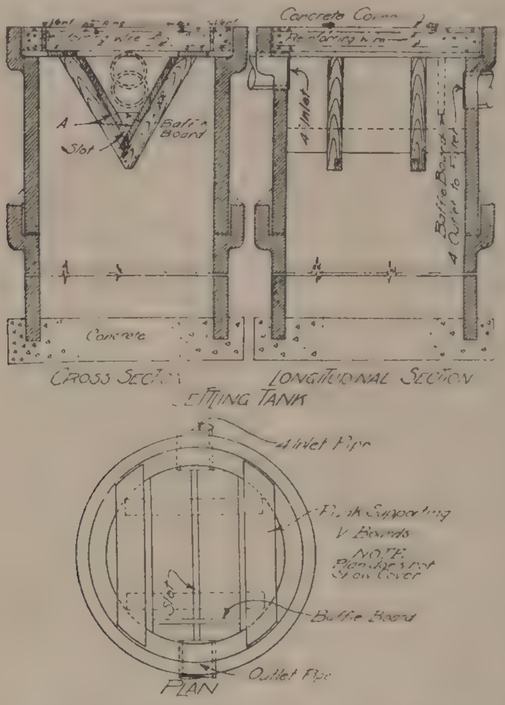
One manufacturer of cement in discussing his difficulties said: "As compared with 1915, cost results for January, 1917, show that coal for power and burning was 25 cents higher per bbl. for finished cement. In other words, the amount we are obliged to pay for coal now has increased the cost of manufacturing a barrel of cement 25 cents, as compared with the early part of 1915. We are paying 35 per cent. higher wages, which has increased the cost of manufacturing cement several cents per barrel. All repair and renewal material has increased in cost by percentages varying from 30 per cent. to 250 per cent. The increase in the cost of insurance, due to the general adoption of the compensation insurance, and the increase in taxes have also added to our cost of doing business 1 cent per barrel. We have been compelled to pay higher salaries. Our operating costs are considerably higher than formerly by reason of frequent interruptions due to shortage of cars and delays in transportation. All of these factors and the general increase in the cost of all items entering into the problem of manufacturing cement have vexed the cement makers and have compelled them to charge more for their product, a situation which is not at all relished by them because of the fact that one of their most prominent arguments for the use of concrete is not only its economy and permanence, but its relative low cost as compared with other materials which for many purposes are rivals of concrete."

A Scheme to Produce Artistic Buildings

One method of accelerating the artistic impulse, and one that would seem to offer great possibilities, has, says the American Architect, been adopted in the South American city of Buenos Ayres. That municipality exempts from taxation each year the most beautiful building erected during the preceding twelve months, and in addition awards a medal to the architect. A more direct form of encouragement, or one that would possess a greater appeal for the average owner, it would be difficult to devise. It is possible that the decoration of the architect may be unnecessary to the success of the plan, but doubtless it is with the idea of taking cognizance rather than paying a reward that the medal is bestowed. The plan might well receive consideration by municipalities in this country. Then, possibly, the average citizen would learn to appreciate the inherent as well as the commercial value of good architecture to an extent that might render unnecessary the offer of any special prize or distinction to induce him to co-operate in the production of architecturally meritorious buildings.

A New Form of Septic Tank

THE drawings show an inexpensive septic tank built on accepted principles for a family of from two to six persons. The cross-section of the tank shows it as if cut down through the centre across the direction of the flow. The tank is constructed by sinking in the ground on a concrete bottom two lengths of 24 in. vitrified tile pipe. All joints must be made water-tight. Through the tank are placed boards in the shape of a V, the bottom left open to form a slot, one board projecting enough at the bottom to prevent gases from the bottom of the tank from rising through the slot. The V-boards are shown at "A." The inflowing sewage enters the tank through the inlet pipe and flows through between the V-boards and out at the outlet pipe on the opposite side of the tank. On its way the solids settle out through the slot in the V-boards and remain in the bottom of the tank. The sediment in the bottom ferments and gases rise from it, carrying with them small particles of partly-rotted sediment. These rising particles strike the outside of the V-boards and are deflected outward, being unable to mix with the inflowing sewage. The gases escape through the vents in the cover of the tank and the particles of sewage, freed from the gas bubbles, again sink and are further digested in the bottom of the tank. The liquids which flow through the tank between the V-boards, being freed from the solids, flow out at the outlet and to the filter. A baffle board placed near the outlet pipe projects several inches below the water level and prevents any solid matter from flowing out with the effluent.



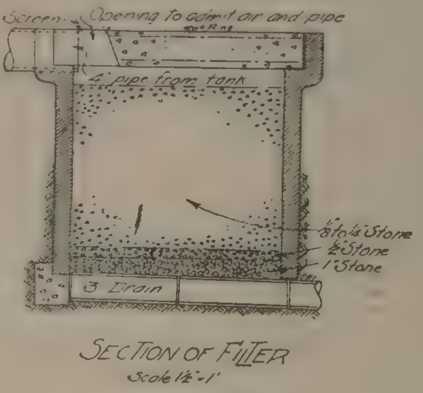
Plan and sections of septic tank made from tile pipe.

A Reinforced Concrete Cover

In constructing the tank care must be taken not to have the inlet and outlet pipes project too far into the tank, as this will cause difficulty in inserting the V-boards. The V-boards are supported by 2 x 2 inch pieces, as shown in the drawings. These are fastened to two planks fitted across the top of the 24 in. pipe inside the bell. Between these permanent planks temporary planks can be laid to act as a form in constructing the concrete cover. Vent holes must be left in the cover as indicated on the cross-section. These may be formed by pieces of tin or short lengths of one or two inch pipe. These are necessary to permit the escape of the gases generated by the decomposition of the solids. Iron rings should be fastened in the top of the cover to facilitate removing it should it ever become necessary. In pouring the concrete cover, tar paper should be carefully fitted around the inside of the bell to prevent the concrete from sticking to the vitrified tile pipe. All permanent wood used should be cypress, since this will not rot and will last indefinitely, whereas any other kind of wood would have to be renewed every few years. The concrete cover should be reinforced top and bottom, as shown, with chicken wire or fence wire. The openings for the inlet and outlet pipes can be cut with a sharp steel point. It is customary when cutting tile pipe to fill the pipe completely with sand, in order to prevent its cracking while being cut.

The Filter

While the proper construction of a septic or settling tank is of importance, the construction of the filter is of as great, if not of greater, importance than that of the tank, for while the tank removes the visible impurities there still remain to be neutralized the noxious elements which are not visible, but whose effect is of as great consequence. The filter shown in the drawing is made of one length of 24 in. tile pipe. This need not have a concrete bottom unless it is near enough to a cellar wall to make it damp or it is desired to lead the effluent directly to a stream. If the bottom of the filter is composed of the natural ground a good deal of the effluent will seep away and be disposed of in this manner. For the same reason the underdrain should be laid with open joints, in order to permit the effluent to enter the ground on its way through the pipes. If the pipe line is long enough the effluent may entirely soak away before reaching the outlet, provided that the grade is not too steep. The main consideration in constructing the filter is the size of the grains used. Over the pipes should be spread a 2 in. layer of broken stone or gravel about 1 in. in size. On top of this spread a layer of ½ in. stone about an inch or so deep. The



Construction of filter.

remaining volume of the filter should be filled with clean, sharp, gravel or screenings not more than ¼ in. nor much less than ⅛ in. in size. It has been found by experiment that this size produces the best effluent, being fine enough for the development of the bacterial jelly and not so fine as to unnecessarily retard the flow through it. If possible it is best to use broken stone in preference to round grained gravel, since the rough surfaces present a better breeding ground for the bacteria. The object of the coarser stone in the bottom is to prevent the finer particles from sifting into the pipes. The bacteria which act in the filter cannot live without air. Therefore, an opening must be left in the cover to permit access of air, or the action of the filter will not be successful.

No Syphon Chambers Necessary

It has been customary in almost all installations to have syphon chambers which permit the tank effluent to be discharged upon the surface of the filter at intervals, the intervening time being necessary for the air to work into the filter to supply the bacteria. In a filter which handles the drainage from one house this is not necessary, since there is never a constant flow, and the filter receives a charge of clarified sewage only when some of the house fixtures are in use, such as the bathroom tank or the emptying of a dishpan into the sink. These discharges occur at intervals as a rule, and allow time enough in between for the aerating of the filters.

Septic tanks built on this principle may never have to be cleaned out, since the storage capacity is sufficient to contain the sludge accumulations of several years. The longer the matter remains in the tank the greater is its reduction in volume. If, however, it should be found advisable to remove the sludge at any time it can be pumped from the bottom of the tank with an ordinary hand-pump and allowed to run out on the ground, where it will dry out without any offensive odor and assume the appearance and character of finely powdered garden mould. Tanks should never be entirely cleaned out, as this removes the colony of bacteria, and the action of the tank will be interrupted until a new colony becomes established.—C. E. Anderson, in the National Builder.

Sewerage Scheme for Essex County, Ont., Municipalities

THE report prepared by Morris Knowles, engineer of the Essex Border Public Utilities Commission, covering a sewerage scheme for the border municipalities, has been accepted by the Provincial Board of Health. This report provides, in the first place, for the establishment of an east interceptor to take the sewage of Ford and Walkerville, beginning at Pelette Road as a 15-inch tile pipe and reaching 30 inches in diameter at the west main sewer in Walkerville. A pumping station equipped with electrically-driven centrifugal pumps will be located near the west main sewer and Sandwich Street, where the sewage will be screened and will run into a gravity main connecting with the Parent Avenue sewer in Windsor. This sewer will be the outlet for the sewage of Ford, Walkerville, and the east side of Windsor. The chief benefit of this plan will be to bring the sewage down below Windsor and Walkerville intakes. There will also be established in connection with the scheme a south interceptor to take the sewage of Ojibway and portions of Sandwich and Sandwich West. This interceptor will commence at Fourteenth and Main Streets in Ojibway as a 27-inch tile pipe, enlarging at Chappus Street to 39 inches diameter, and again at Bedford Street to 42 inches, and continuing through Prospect and Russell Streets to Park Street, where it will be lifted by means of a temporary pumping station into the existing sewer outfall. The total cost of the whole project, including these two separate schemes, is estimated at $210,000, apportioned as follows: Ford City, $70,900; Walkerville, $17,200; Windsor, $10,800; Sandwich, $11,800; Sandwich West, $36,800; Ojibway, $62,800. In 1930 it is proposed to link up the two sewer systems, at an estimated cost of $900,000 for the whole undertaking.

Increase in Canadian Canal Traffic

A government report shows that there was an increase of 8,384,688 tons in traffic through Canadian canals during the season of 1916. The total volume of traffic last season was 23,583,491 tons, as against 15,198,803 in 1915. A great increase was shown in the traffic through the canal at Sault Ste. Marie. The total traffic through this waterway during the season of 1916 was 16,813,649 tons, as against 7,750,957 during the previous year. The traffic through the St. Lawrence canals during 1916 totalled 3,368,064 tons, and through the Welland Canal 2,544,964 tons.

The total volume of wheat moved through the Soo Canal last season was 185,003,667 bushels, and of this quantity 82,807,342 bushels passed through the Canadian channel. The larger accommodation on the St. Mary's side of the river, says the report, probably accounts for the larger portion of the traffic going through the American channel.

The following little ditty, offered by one of the cement companies and sung to the tune of "John Brown's Body," perhaps throws some light on the elusive cement sack:—

The Polak needs an apron to protect his dainty waist;
He beats it to the pile where all the empty sacks are placed,
Picks out the best that he can find and then skidoos in haste—
And one more sack is gone.

Chorus

Some one's going to lose the money,
Some one's going to lose the money,
Some one's going to lose the money,
For one more sack is gone.

The Dago has to work on ground that is a trifle wet,
But will he get pneumonia? No! he will not—you can bet!
He wraps his feet in empty sacks—they never stopped him yet—
And one more sack is gone.

The Hunkie wants a handy bag for carrying his tools;
The sacks are lying all around—there are not any rules
To keep the men from stealing them—they teach it in the schools—
And one more sack is gone.

The Ginny slips, and though, by luck, he isn't badly hurt,
He sees upon his lingerie a tear and maybe dirt.
He steals a sack and takes it home to make another shirt.
And one more sack is gone.

The Water Powers on Western Rivers

Data Obtained by Commission of Conservation Show Power Possibilities of the Hayes and Saskatchewan Rivers

Hayes River

The Hayes River drains an area east of the Nelson River and empties into the Hudson Bay a few miles from the mouth of the Nelson.

The discharge of the Hayes River, metered on August 5, 1913, at a point four miles below "The Rock," was 3,265 cubic feet per second. The width at this point was 252 feet, the maximum depth seven feet, and the greatest mean velocity in any one section 3.45 feet per second.

"The Rock" is the lowest portage on the river, and between it and Swampy Lake, 35 miles upstream, the descent occurs in short rapids; these are not very steep but the current between them is strong.

The available theoretical horse-power given for two of the largest falls on this river is 6,350 each under a head of 35 ft. There are numerous other falls estimated at 1,500 h.p. and smaller.

Saskatchewan River

The North Saskatchewan and South Saskatchewan rivers, uniting at the forks, form the Saskatchewan River, which after traversing part of the province of Saskatchewan and Manitoba, empties into the north-western part of Lake Winnipeg.

On the main Saskatchewan River between Cedar Lake (Manitoba) and Lake Winnipeg, Grand Rapid occurs in a large bend where the river is about 1,300 feet wide. It affords good conditions for a development with a head of 80 feet. The estimated capacity is 41,000 h.p. Between the Red Rock and Grand Rapids, the river is from 600 to 900 feet wide. At two other points in this district estimated powers of 7,700 h.p. are listed. Four other falls situated on the main river in the province of Saskatchewan are rated respectively 10,000, 9,500, 2,700 and 1,900 h.p.

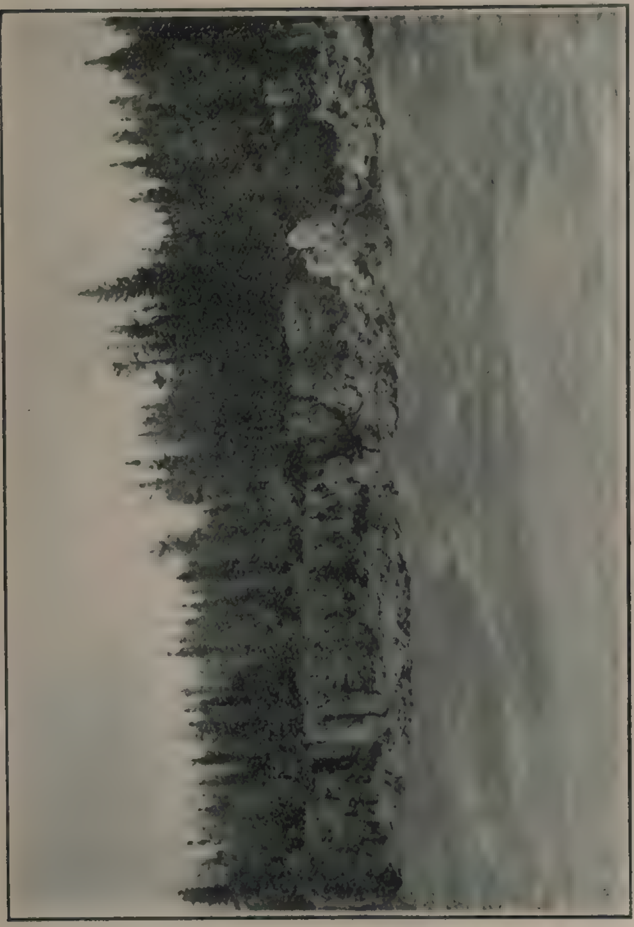
The main river, as already noted, is formed by the junction of the North Saskatchewan and South Saskatchewan, some 30 miles east of Prince Albert, Sask. In the immediate vicinity of the junction point there are four possible power sites on the north branch rated approximately at low water capacity of 3,000, 2,000, 2,000 and 3,000 h.p. The only other waterfall of any considerable importance on this river in the province of Saskatchewan is on the south branch, some 15 miles north from Saskatoon, where a 15-foot head is available and a minimum of 1,700 h.p. Some time ago considerable work was done on the construction of a dam for the development of this power for the city of Saskatoon, but the work is at least temporarily abandoned.

The north branch of the Saskatchewan River rises in the Rocky Mountains and traverses from west to east, therefore, the whole of the province of Alberta. There are a number of possible power sites, most of which are small. The largest is that known as Rocky Rapid, some 75 miles west of Edmonton, where, with regulated river flow, it is calculated 28,000 h.p. could be developed. This is much the largest power on this river in the province, though three others are rated in the neighborhood of 1,000 h.p. minimum natural flow.

The south branch of the Saskatchewan rises in the extreme southern part of the province of Alberta and is augmented by a number of tributaries—the Red Deer, the Bow, Belly, St. Mary and others. On the Belly River midway between Macleod and Lethbridge, there is an estimated power of 1,200 h.p. On the South Fork River, near the West Kootenay Pass, there are three powers estimated at less than 1,000 h.p. each, minimum flow. On the Crow's Nest branch, there is a possible head of 40 ft. and a minimum development of 300 h.p. On the St. Mary River and other small creeks and rivers immediately north of the boundary line there are a number of comparatively high falls of very small capacity. One on the St. Mary is rated at 384 ft. head, with 3,400 h.p. minimum. Another on Tib Creek has a fall of 349; another on Oil Creek has a fall of 250 ft., but the minimum development is only 392 h.p. Other small falls in the district are 158 ft., 127 ft., and 50 ft. high, respectively. On the Bow River tributary of the South Saskatchewan, there are a number of falls of considerable size, varying in head from 12 to 70 ft. At Bassano there is a drop of 38 ft.; at the city of Calgary, a fall of 12 ft.; at Radnor, a fall of 44 ft. and a minimum of 3,500 h.p.; Ghost Fall has a head of 50 ft. and a minimum of 4,000 h.p.; Mission, a fall of 47 ft. and a minimum of 3,200 h.p.; Bow Fort, a fall of 66 ft. and a possible regulated development of 11,240 h.p. Horseshoe Fall has a drop of 70 ft. and a regulated capacity of 11,910 h.p. At this point the Calgary Power Co. has installed a capacity of 19,500 h.p. At Kananaskis Falls the Calgary Power Co. has 12,000 h.p. installed. At Banff there is a 64-foot head and a minimum development of 1,500 h.p. On the Elbow River there is a head of 225 ft. and a minimum development of 4,500 h.p. possible. On the Kananaskis River there is a series of falls, 70, 70 and 45 ft. On the Cascade River, a 64-foot head with a calculated regulated capacity of 1,450 h.p. On the Spray River a fall of 50 ft. is available. On Lake Louise there is already a small C. P. R. plant in operation, generating about 130 h.p.

It will thus be seen that though the River Saskatchewan and its tributaries traverse three provinces, there is probably little in excess of 200,000 h.p. natural minimum capacity in its many water-falls. The chief characteristic of the rivers that rise in the Rockies, is the extreme variation between maximum and minimum discharge—sometimes as great as 200 to 1—and the sudden rises that occur in these streams. The North Saskatchewan and South Saskatchewan receive the greater portion of their flow from the mountains and are affected by extremes of temperature in the high altitudes. In these rivers and in the main Saskatchewan the discharge varies greatly during the year; high water and floods, due to warm rains and hot weather in the mountains, usually occur during July and August, while the low flow occurs during February and March. This also applies to their mountain tributaries and consideration of this is a factor of vital importance in designing hydro-electric developments on these streams. At The Pas the range between these two periods is ordinarily some 15 feet, which, at Grand Rapid, is gradually lessened, to from four to five feet, with an extreme of some six feet. During the spring break-up, the field ice of Lake Winnipeg occasionally becomes jammed at the mouth of the river, damming the outlet and causing rise at the lake of from 12 to 15 feet.

It is thus exceedingly difficult to form an estimate of any of the powers on this river. Under regulated flow possibly a million horse power or more is available. It would appear, however, that the development of the waterfalls must wait a general scheme of regulation which would be far too expensive for any single municipality to undertake.



Saskatchewan River—Grand Rapid

Saskatchewan River—Red Rock Rapid

Hayes River—Knife Rapid

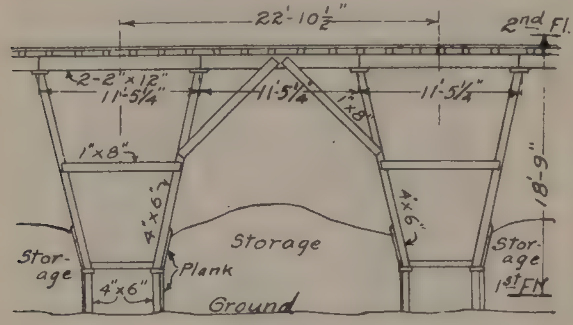
Hayes River—Trout Fall

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Special Form Supports Provide Storage Within Building

WHEN the recently completed mail-order building of the Robert Simpson Company, Mutual Street, Toronto, was under construction, Mutual Street, which was the only adjoining thoroughfare, had to be kept open for traffic. As the site was completely occupied by the building, this meant that storage space for sand, gravel, and cement had to be provided within the building itself. To secure sufficient room specially-designed form supports were employed on the ground floor, with timber bents providing a wide spacing for storage. As the ground floor storey height was 18 ft. 9 in. and there was no basement, these bents were quite applicable, and found as economical as ordinary shoring. The accompanying sketch indicates the arrangement. The bents were constructed on the job, and were all alike. They were erected on 2 in. plank caps, resting on short 4 in. x 6 in. shores, which were placed and then cut off to grade. The bents were tapered, giving a space between the bents of 11 ft. at the top and 17 ft. at the bottom. This bent construction was carried out for a width of six bays, thus providing six passages facing the street, which were carried through for a depth of three bays. At the end of the aisles the fourth bay was arranged lengthwise for the whole width of six bays. Each passage was 17 ft. wide and 75 ft. long, with a storage capacity of 250 yards. Teams would drive from the street into any of the first five bays and dump, returning by the connecting passage and the sixth bay, which was reserved for return only. Two bays were used for sand, two for stone, and one for cement. The total storage capacity was thus 1,250 yards.

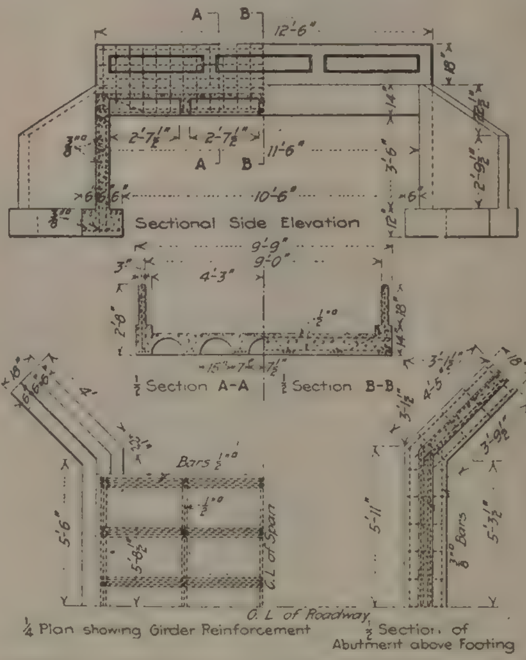


Widely spaced bents instead of plain shoring provide storage space during construction.

New Bridge Design Saves Concrete

IN the solid flat slab reinforced concrete highway bridge the great weight of concrete contained is serious, for several reasons. A great proportion of the bridge's strength is required to carry the weight of the superstructure, in many cases only 30 per cent. of the strength being available for live load support. Another disadvantage is the difficulty of supporting the concrete when pouring in the forms. In many cases insufficient support has been supplied, and the temporary false work has settled under the load of the concrete, resulting in actual damage to the strength of the bridge, as well as giving an unsightly appearance to the structure. The Minnesota State Highway Commission has designed a new type of construction, illustrated herewith, which is more economical than the flat slab superstructure, as well as being lighter and thereby avoiding some of the difficulties encountered with the solid slab.

The new type is cored out on the under side by semi-circular arches of corrugated metal, which form longitudinal reinforced concrete tee-beams, with cross beams, as shown in the figure, which is a plan for a half-size model of a 23-foot span, 18-foot roadway bridge. This type uses one third less concrete than the flat slab designs, and the forms are cheaper, as the corrugated metal arches are removed after the concrete has set, and can be used repeatedly.



Underside of bridge cored out by removable semi-circular arches of corrugated iron.

To test this type of construction a half-size model bridge was built according to the dimensions shown and subjected to severe loading. The result showed this economical design has sufficient stength to carry with perfect safety a 20-ton load with 15 tons on one axle on a full-size bridge, as is required by the Minnesota law.

Messrs. S. B. Coon & Son, architects, Toronto, announce that they have removed their offices from the Ryrie Building to No. 810 Excelsior Life Building.

Explosive Thawing Methods

DYNAMITE when crystallized or, as is commonly said, frozen, is less efficient, since it becomes less sensitive to shock. Frozen dynamite, on other hand, is dangerous, because vigorous friction may cause it to explode. In cold weather it must be thawed before using, a process which is not dangerous if carried out along approved lines. Accidents that have happened in thawing are chiefly due to the use of improper or imprudent methods.

Three different kinds of dynamite are on the market—the ordinary dynamite, freezing between 46 degrees F. and 52 degrees F.; the low-freezing dynamite, freezing below 35 degrees F., and the non-freezing dynamite, freezing below 10 degrees F. In thawing, indirect heat should be applied slowly. Sticks should not be placed near a source of direct heat, such as a boiler, fire, steam pipe, hot water, or even in the direct rays of the sun. The employment of body heat is also attended with danger.

Small quantities of dynamite may be thawed by using a water-jacketed vessel with water not above 130 degrees F. The cartridges should not be put directly in the water, but the thawing should depend on transmitted heat. A manure box, consisting of a tight box surrounded by 18 inches or so of fresh manure, is suitable for the thawing of a considerable quantity of the explosive, and the method is cheap but slow.

The most satisfactory and the safest means of thawing explosives is by steam. Exhaust steam is usually available, but, in any case, the pressure should not exceed three pounds. The thaw-house, besides being isolated, should be well protected from the cold and well ventilated. Racks should be arranged for the cartridges, and must be distant from the heating coils. Hot water coils are applicable in thaw-houses, but the same precautions must be taken. Further, the heater must be at least 12 feet from the building in which the explosives are being thawed. Hot water has some advantage, in that it provides a very uniform heat.

Hot air, although frequently employed, is not completely satisfactory. The heat is difficult to regulate, and there is always danger of defects in the chimney occurring, giving passage to gases and smoke and sometimes flame. The stove must be at least 12 feet from the thaw-house. Electric heaters, resistance or lamp type, are more satisfactory than stoves for producing hot-air circulation, but this method is more wasteful and less safe than low pressure steam. Danger from sparks and flashes is always present.

Underground thaw-houses, as sometimes used in mine work, should be located in an out-of-the-way drift, in such a way that accidental explosion would not cut off the escape of the men working in the mine. A very serious danger to men working in such a thaw-house is lightning.

John Hayman & Sons have purchased a half-yard batch mixer from the London Concrete Machinery Company, to be used in the erection of the new theatre to be built by the Canadian Theatres, Ltd., at Montreal.

The London Concrete Machinery Company have secured the contract to supply Messrs. D. Jannison & Son with a half-yard London batch mixer, to be used in building the Spanish River Pulp and Paper Mills at Sturgeon Falls.

Trade Publication

The Hydrated Lime Bureau has issued a bulletin, "Modern Methods in Concrete Construction," referring to the use of hydrated lime in concrete. It contains letters from various prominent engineers and contractors, outlining their experiences with hydrated lime in their actual field practice on large and important concrete operations. This bulletin will be supplied gratis on request.

Mainly Constructional

East and West—From Coast to Coast

The local contracting offices of the Dominion Bridge Company, Lachine, have been removed to Rooms 803-805, 285 Beaver Hall Hill, Montreal.

During the month of April there were 21 building permits issued in Peterboro, Ont., at a value of $18,910, as compared with 17 in April, 1916, at a value of $39,815.

Work on the Pape Avenue extension of the Toronto Street Railway is progressing as rapidly as possible. Overhead work is nearly completed and delivery of rails and curves is to be made in June.

The Steel Company of Canada is having new concrete docks built at its ore docks at Point Edward, Ont. The work will be carried out at a cost of about $20,000, and will greatly increase the efficiency of the docks.

Twelve steel road drags have been purchased by the council of Waterloo Township, Ont. Six have been shipped to Kitchener by the Sawyer-Massey Company, and an equal number to Preston for the southern division of the township.

Carriere Roberge, Limited, is the name of a company incorporated with a capital of $49,000, to deal in stone, cement, concrete, lime, brick, tiles and other construction materials, and to acquire the business of Roberge and Giroux, Chateau Richer, Co. Montmorency, P.Q.

The building permits issued in Vancouver for April this year number 49, and are valued at $73,824, as compared with 38 at a value of $64,605 for the same month in 1916. The total for the first four months of the year is 168 permits, valued at $233,364, while in the same period last year there were 132 permits issued, at a value of $358,350.

Mr. George McNamee, of Montreal, secretary of the Dominion Good Roads Association, will be invited to Hamilton, Ont., to look over the accommodation which the city can provide for a good roads convention, should it be decided to accept the invitation to hold the next Canadian and International Good Roads Congress in Hamilton.

The building permits issued in St. John, N.B., during the month of April total $24,500 in value, compared with $46,800 in the same month last year, a decrease of $22,300. The total for the first four months of the year, however, shows a large increase over the corresponding period in 1916, the figures being $388,000, as against $81,600.

The Copeland-Inglis Shale Brick Company, Birmingham, Ala., has become a licensee of the Dunn Wire-Cut Lug Brick Company of Conneaut, Ohio, and will henceforth make wire-cut lug paving brick. This is one of the largest and most important paving brick concerns in the South. Mr. Beattie A. Inglis is vice-president and treasurer and Mr. W. Lawton Inglis is secretary.

The building permits issued in the city of London, Ont., during the month of April this year number 140, and are valued at $84,290, as compared with 138 permits in the same month last year, valued at $82,550. For the first four months of the year the total is 235 permits at a value of $163,330. This compares with 212 permits during the corresponding period last year, valued at $160,765.

An elaborate and well equipped theatre is being erected at the Whitby Hospital for the Insane which is being turned over to the Military Hospital Commission to take care of convalescent soldiers. When the main hall is completed, professionals will be engaged regularly to play at the theatre for the entertainment of the soldiers. The building will seat 1,200 persons. The stage will be 40 ft. wide, the whole auditorium being 70 ft. in width.

Permits for 620 new buildings having a total value of $594,652 were issued in the city of Toronto during the month of April this year, as compared with 441 new buildings, having a total value of $457,646, during April, 1916. New buildings for which permits have been granted during the first four months of 1917 are valued at $1,997,557, as compared with new buildings worth $1,121,435 in the first four months of 1916.

The Good Roads Commission of the province of Quebec have accepted the tender of Messrs. Langaniere, Houde & Company, of Grondines, for the building of a bituminous macadam pavement between the city limits, on St. Foye Road, and St. Augustin—a distance of about 10 miles, on condition that the contractors use Ubane asphalt, and that the municipalities give their sanction to the work. The tender of this firm was the lowest received.

The cost of widening the Toronto-Hamilton Highway from Etobicoke Creek to the city limits of Toronto has been apportioned by the Ontario Railway and Municipal Board as follows, the total estimated expenditure being $314,771: The Highway Commission, $100,489, or 31.92 per cent.; the city of Toronto, $70,542, or 22.41 per cent.; the village of Mimico, $69,094, or 21.95 per cent.; New Toronto, $52,394, or 16.64 per cent.; Etobicoke Township, $22,251, or 7.08 per cent.

Work has recently been started on a new C. P. R. station at Dryden, Ont., the contract being in the hands of J. H. Simmons, of Winnipeg. The building will be 136 ft. long and 22 ft. wide. It will contain a general waiting room, 27 x 22 ft., office, 18 x 22, baggage room, 15 x 22, freight shed, 73 x 22. The structure will be one storey, 11 ft. high to the ceiling, and a 5-foot awning will project all around it. A concrete basement for the heating apparatus will be constructed under the office portion.

The Works Committee of St. Catharines, Ont., at a recent meeting of the city council presented a report recommending the laying of concrete sidewalks on sections of the following streets: Elberta Ave., Main St., Leeper St., McDonald St., Highland Ave., Vale Ave., Russell Ave., Brighton Ave., Trapnell St. Pavements are recommended on John St. from Queenston St. to Seneca St.; on Cherry St., from Ann St. to Trafalgar St., and on Ontario St. from Welland Ave. to N. S. & T. Ry. tracks. The installation of a vitrified tile sewer on Geneva St., between Russell Ave. and St. Patrick St., is also advised in the report.

If the city of Brantford, Ont., wishes to have a vehicular subway at St. Paul's Avenue, it will have to bear the greater share of the cost, according to the decision of the Dominion Railway Board. The board is willing to grant an order for such a subway, but the city will have to bear all the cost additional to that which it would cost to place a pedestrian subway at this point. For a pedestrian subway only the Grand Trunk Railway would have to pay $4,800. The board would allow a sum not exceeding $5,000 to go towards the cost, from the railway grade crossing fund, and as the estimated cost of the subway is $45,000, the outlay required by the city would be $35,200.

Personal

Mr. G. L. Wallace has been appointed by the Toronto Board of Control as structural engineer in the City Architect's department, taking the place of Mr. R. J. Fuller, who has resigned.

Mr. Guy Robert Ramsey, Assoc. M. Am. Soc. C. E., of Orlando, Florida, has joined the engineering staff of the Dunn Wire-Cut Lug Brick Company of Conneaut, Ohio, and will be division enginer for the southern states, with headquarters at Atlanta, Ga.

Mr. P. Philip, who for seven years has been assistant in the city engineer's department of Vancouver, has now resigned, having been appointed supervising engineer for District No. 3 by the provincial government. In this capacity he will have charge of road and bridge construction.

Mr. Walter J. Francis, M.C.S.C.E., Montreal, has been engaged by the Saskatchewan Government to investigate the construction of the bridges, highways, and roads recently built in the province. This is in connection with a Commission appointed to deal with the matter. Mr. Francis is now in Regina.

Mr. Geo. McKnight, city engineer of Fredericton, N.B., has tendered his resignation and requested that he be relieved of his duties as soon as possible. The principal reason for Mr. McKnight's giving up office, it is stated, is because he considers the funds allowed to his department altogether inadequate for the work to be carried on.

Mr. B. E. Michel will be Kitchener's new city engineer, according to the decision of the city council at a recent meeting. He takes the place of Mr. H. Johnston, whose resignation is requested, but against whom no charges of incompetency are preferred. The new engineer is, however, being engaged at a smaller salary than that received by Mr. Johnston.

Gunner Roger Allan Macdonald, son of Mr. and Mrs. J. R. Macdonald, of Stratford, Ont., has been wounded and is reported seriously ill, suffering from a gunshot wound in the head. Gunner Macdonald enlisted over a year ago with the 54th Battery in Toronto and had been serving with the 6th Battery at the front for several months. He had just received the degree of B.A.Sc. from the University of Toronto before he enlisted.

Wettlaufer Bros. Secure Contracts

Wettlaufer Bros. advise that they were awarded contract by the city of Ottawa for one No. 2 Elevated Road Paving Mixer, with gravity chute. This firm also report that the Fredericton Concrete Company, of Fredericton, N.B., has placed contract with them for a complete plant of tile, sewer pipe and brick making machinery, which consists of special automatic mixers, screens, elevators, crushers, crushing rolls, tile and sewer pipe machines, and power brick presses, brick and tile cars. This plant is now in operation, and is manufacturing all concrete products under special steam process. It is the only plant in operation today in the Maritime Provinces, manufacturing concrete pipe, brick and tile, with power machinery. Wettlaufer Bros. are now preparing their fourth shipment, to be despatched to Paris, France, consisting of 41 pieces, mixers, brick presses, block machines, tile machines, etc.

Mr. S. R. Sheldon, vice-president and chief engineer of Sheldons, Limited, Galt, Ont., manufacturers of fans, recently passed away. The late Mr. Sheldon was originally with the McEchren Ventilating Co., but later the business was taken over by him in partnership with his brother, Mr. W. D. Sheldon, and some years ago incorporated as Sheldons Limited.

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **May 23, 1917** **No. 21**

Principal Contents

Page
Editorial 449
America's Longest Railway Tunnel 451
A Ten-Storey Warehouse 459
The Tallest Chimney in the World 459
Repairing Destroyed Bridges 460
Standardized Steel Frame Construction 461
Cement Concrete Roadways of Ontario 463
Ruthenian Catholic Church 464
Practical Hints for the Contractor 465
Mainly Constructional 466

Record Breaking Tunnel Methods

THE completion of the Connaught Tunnel a few months ago draws the curtain on what is without doubt the most notable achievement in the art of tunneling ever accomplished on the American continent. The rapidity with which operations were carried out was, possibly, the most outstanding characteristic of the work. To complete a rock tunnel, five miles long, in practically three years, under conditions not by any means easy, is an undertaking that might well be termed a brilliant success. That the contract was completed eleven months ahead of the allowable date is a splendid tribute to the organizations that have had this matter in hand. They were facilitated in their progress by a sufficient backing of money and authority, coupled with a free hand, and during the whole time no strikes or interruptions occurred to mar the continuity of their plans.

The rapid headway made stands as a record in American tunneling methods. European methods have always proved speedier than those adopted on this side of the Atlantic, but the lack of the abundant cheap labor that makes the application of these methods in Europe possible at low cost precludes similar headway in America, unless at an exorbitant expense. The growing traffic congestion of this division of the Canadian Pacific Railway lines can be thanked, in part at least, for the speed that was exhibited. This fact led the railway officers to regard the time of completion as more important than any other consideration, and in letting the contract the guarantee of completion in the shortest time carried more weight than the cost.

* * *

To meet the urgency demanded by the railway methods somewhat removed from the conventional were obviously a necessity. In this work, therefore, we see the adoption of bold innovations that are distinct advances in the science of rock tunneling. For these radically novel methods credit is due to Mr. A. C. Dennis, superintendent of the contractors, Foley Brothers, Welch & Stewart, and Mr. J. G. Sullivan, chief engineer of the C.P.R. Western lines, whose collaboration resulted in the perfected scheme of attack. They did not hesitate to throw precedent aside if by doing so they were succeeding in accomplishing the desired end in a more efficient manner, which meant in this case a more speedy manner. The rapidity of headway was a result of the combination of two elements—a new mode of heading attack and a revised plan of enlargement. In each of these distinct progress is evident upon the practices heretofore accepted.

The pioneer bore, inaugurated as an experiment, was, it will be remembered, looked upon with distrust by many authoritative tunneling engineers. They regarded its efficacy as questionable because it did not follow the precedent set by prior rock tunneling. But the initiative of the engineers produced results, and the experiment made good—just how good the actual time figures give sufficient evidence. In the article on the Connaught Tunnel, printed elsewhere in this issue, the advantages that accompanied the adoption of this scheme are outlined and, in a word, the chief argument in its favor seems to be that it was possible for the main heading progress, enlargement drilling, blasting, and mucking to be operating continuously and simultaneously without interference. All fears as to the development of dangerous internal pressure conditions through the proximity of the pioneer bore to the main tunnel proved groundless.

The enlargement operations further demonstrated the success of progressive ideas. The adoption of a central heading of such size as to permit radial drilling for the final enlargement proved well worth while, as the speed of driving, averaging 15 to 20 feet daily, constituted a record. The enlargement by blasting in rings on planes perpendicular to the tunnel axis made for phenomenal progress and, although an innovation, led to absolute success.

* * *

Not only in the actual methods of heading and enlargement driving was success apparent, but likewise in the co-ordination of operations and their planning in such a way as to obviate overlapping and mitigate delays The speed of the undertaking was further accelerated by the scheme of payment which provided an inducement for rapidity of work The bonus scheme outlined in our article adequately compensated the workmen for any extra spurts they might exhibit, and offered an ample incentive for speedy results. By making the gang rather than the individual the unit, and having the bonus paid to the gang, the system succeeded in securing the maximum efforts from the men as the gang took upon itself the responsibility of correcting its tardy or incompetent members.

An insight into the progress in the art of tunneling can be no better gained than by a perusal of the Connaught Tunnel methods. Radical as they may have seemed three years ago, their success is their future recommendation. Engineers throughout the world have watched with a great deal of expectancy the results attending these experiments. Their eyes have been opened because the experiments have made good. Because they have made good, the stereotyped processes are doomed to revision at least, and the success at Rogers Pass will be an incentive for still further progress in this very important branch of engineering.

Better Building Reports

NOW that the building season in Montreal has commenced in earnest, it is evident that it will be an improvement on last year. More activity has lately been shown, and although the permits do not indicate any substantial increase in number, the average value of the buildings is considerably higher than in 1916. The total gain for the four months is about $700,000, and this despite a considerable rise in most classes of building material. The greater number of permits is for apartments and flats, which are in demand, on account of an influx of population, due to munition work. In the neighbouring city of Maisonneuve it is officially stated that the requirements in the way of residences, chiefly for working people, far exceed the supply, and the city are anxious to encourage building of this character. The reports from different parts of the province are fairly good, and it looks as if the agricultural districts in particular will have a satisfactory building season, although the municipalities are not spending large sums on municipal work, except where it is absolutely necessary. The very sharp advance in the price of lumber and also its scarcity is a factor which has to be taken into account in considering the prospects of building and contracting work.

Thrift in Municipal Expenditures

IT is evident that the financial conditions at the present time are unfavorable to the carrying out of municipal enterprises, as the Canadian bond market is non-receptive, and now that the United States has entered the war, the outlook is more unpromising than ever, owing to the demands which are being made by the United States Government for capital. Attention is called to this fact in a statement submitted to the Toronto board of control by Works Commissioner Harris and City Treasurer Bradshaw, in which it is pointed out that the city has not made a sale of bonds since last November, owing to the unfavorable situation, and it is urged that the most rigid economy must be practised. These officials point out that a number of works are proceeding which were commenced some two or three years ago, and which the city is obligated to complete, and some of them have not been financed as yet. These and other works which have recently been carried through on temporarily borrowed capital, together with war expenditures, will require that the city borrow in the neighborhood of nine million dollars. "It is absolutely essential, therefore," they continue, "because of the foregoing conditions, and also because of the present heavy capital indebtedness of the city, and the debt charges associated therewith, that we shall not embark upon any new capital expenditure whatever, unless legally compelled to do so. It is realized that there are many undertakings which, if conditions were normal, and if our finances would warrant, should be proceeded with, but we must recognize that conditions are not normal; that we are in a period of financial uncertainty, and that our present financial conditions do not encourage us to add to our already heavy burdens."

Summer Plans of Saskatchewan C.S.C.E.

AT the regular May meeting of the Saskatchewan Branch of the Canadian Society of Civil Engineers—this name has now been approved by the parent society—the following officers were elected: Chairman, L. A. Thornton, city commissioner, Regina; vice-chairman, Geo. D. Mackie, city commissioner, Moose Jaw; secretary-treasurer, J. N. de Stein; Executive committee—E. G. Montgomery, Regina; H. S. Carpenter, Regina; A. H. Dion, Moose Jaw; C. J. Yorath, City Commissioner, Saskatoon; Professor A. R. Greig, agricultural and engineering department, University of Saskatchewan.

It was decided to hold a general meeting in Regina on May 23 to discuss the Canadian railway problem. The Premier of the Province and other prominent public men will be present.

The July meeting will probably take place at Fort Q'Appelle, to give the members an opportunity of visiting the sanitarium at that point. In August a visit to Moose Jaw is being arranged, for the inspection of the public works of that city.

At the meeting of May 10, Mr. Walter J. Francis, C.E., of Montreal, was present and addressed the Branch. Mr. Francis spoke particularly of the attitude of the Canadian Society towards the employment of alien engineers and the steps that are being taken to bring the matter before the Dominion Government. Mr. Francis also spoke of the apparent lack of interest on the part of engineers in political matters, pointing out that not one single member either of the House of Commons or of the Senate is an engineer by profession. The speaker also directed attention to the fact that approximately one-quarter of the 3,000 members of the Canadian Society of Civil Engineers in Canada are on active service to-day.

Montreal Aqueduct Again

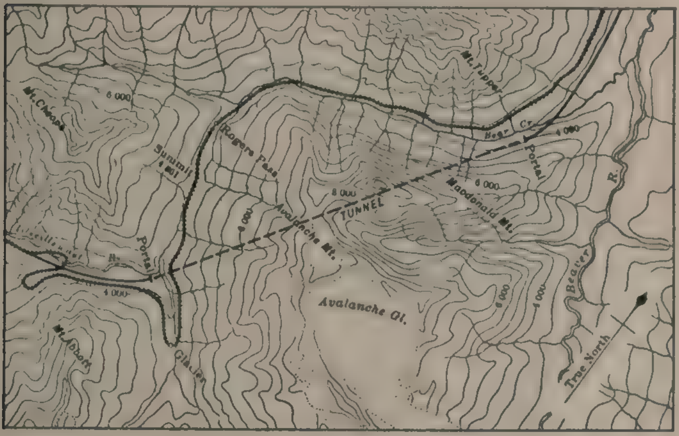
The committee of engineers recently appointed to make a report on the Montreal aqueduct system have presented the findings to the Board of Control. The report is signed by Messrs. H. E. Vautelet, Chairman, A. St. Laurent and J. B. McRae. The report in general is unfavorable to the scheme of power development as originally planned. The problem appears to hinge very largely on whether, having already expended several million dollars on this work, it would not be more economical to complete it than to lose entirely the value of the money expended.

Messrs. Carter, Halls & Aldinger have awarded the steel sash contract on the Canadian Bag Company's warehouse, at Winnipeg, to the A. B. Ormsby Company, Ltd., Toronto.

America's Longest Railway Tunnel

The Connaught Tunnel on the C. P. Railway Through the Rockies, Five Miles Long, Driven with Phenomenal Speed by the Application of Radically Improved Methods of Rock Boring

THE Rogers Pass tunnel, officially known as the Connaught Tunnel, on the line of the Canadian Pacific Railway through the Selkirk Range of the Rocky Mountains in British Columbia, was placed in service on December 9, 1916. Besides being the longest railway tunnel in America, it occupies a noteworthy and unique place among projects of this kind, inasmuch as entirely new methods of tunneling resulting in unprecedented speed, were demonstrated with success. Details of the work, with progress articles, have appeared in the Contract Record at various times, notably April 8, 1914, Sept. 9, 1914, Dec. 23, 1914, Mar. 17, 1915, Nov. 24, 1915, Jan. 26, 1916, June 28, 1916.



Plan of Rogers Pass or Connaught tunnel—It shortens line by 4.3 miles and lowers summit 552 feet.

The tunnel is five miles long, double-track, and was carried out at a cost of $6,500,000, as part of a 10-mile local improvement to the main line of the C. P. R. at this point. This adjustment was made necessary by the increasing congestion of traffic, which made an immediate double tracking essential. Rather than make the improvements to the existing location, the railway decided on a new alignment, which would effect some very important advantages. The objects that have been attained include the saving of 4.3 miles of distance, the lowering of the summit of the former line by 552 ft., the elimination of about 2400 degs. of curvature, the reduction in the length of the east and west pusher grades of nine and eight miles respectively and the elimination of the expense and danger of maintaining the operation of 4½ miles of snowshed.

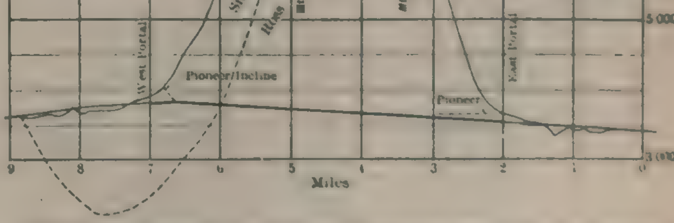
Tunnel Part of a Local Improvement

The transcontinental line of the C. P. R. crosses the Selkirk Mountains at an elevation of 4,300 feet through rugged country, with 2.2 per cent. grades on the approaches, which are 21 and 25 miles long on the east and west sides respectively. The whole improvement at this point involves a change of line 10¼ miles long, most of which is east of the tunnel. The re-location to the west of the tunnel saves a distance included in two spiral loops on the old line. A six-track yard just west of the tunnel with three short girder bridges is also included in this re-location. The tunnel is 26,500 feet long, with provision for two tracks spaced 13 feet centre to centre with a horizontal clearance of 8 feet from centre of track and vertical clearance of 20 feet above base of the rail measured on the centre line of the track. A grade of 0.95 degs. exists throughout the length of the tunnel, ascending westward.

The rapidly increasing traffic on this part of the line made speed a very urgent consideration in the construction of the tunnel, and for this reason special studies were made to devise a method of driving that would prove most rapid. The topographical location of the tunnel through a mountain which rises almost abruptly from the portals and reaches an elevation of about 6,000 feet above the roof, made it impossible to utilize vertical shafts for the driving of intermediate headings. Adits were also impracticable. The work was thus restricted to operations from the two portals. The usual American method of driving a double heading and taking out the bench with a power shovel was obviously too slow, and the European method of a bottom heading and stoping out the rest, while two or three times as rapid, was too expensive with labor costs as found on this continent.

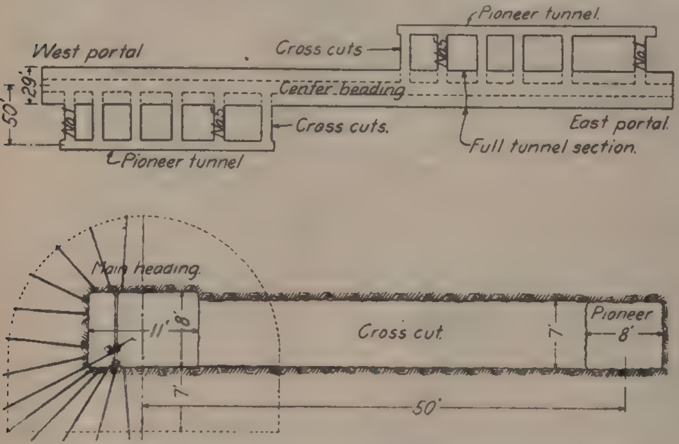
Pioneer Heading Distinguishes Work

The method ultimately adopted was devised by A. C. Dennis, superintendent for the contractors, Foley Bros., Welch & Stewart, and revised as to detail by J. G. Sullivan, chief engineer, C. P. R., western lines. It involved the use of an auxiliary or pioneer heading entirely outside and independent of the tunnel proper, and which was driven at the maximum speed. The cross-section was as small as could be worked satisfactorily. From this pioneer heading drifts or cross-cuts were driven at intervals from the centre line of the main tunnel, thereby affording numerous points from which advanced centre headings could be driven in the tun-



Profile of Connaught tunnel showing modified location of pioneer portals.

nel proper. This method, which is unprecedented, was justified for the following reasons: (1) It provided a means for the transportation of the muck from the various headings and from shovel operations in the enlargement of the main tunnel; (2) adequate ventilation of the heading was secured, for the pioneer tunnel served as an intake for forced circulation of fresh air through the cross-cuts and cut of the main tunnel, enabling work to be resumed immediately after blasting the main tunnel enlargement; (3) water, air and ventilation pipes were conducted to the headings, so as to be entirely undisturbed and independent both of blasting and power shovel operations incident to the enlargement of the main tunnel to full size; (4) it expedited the work of enlargement of the main tunnel by making it possible to drill the main headings for enlargement as far ahead of, and without interference from or with, the main tunnel blasting or mucking for enlargement; (5) it supplied a route for men, tools and materials; (6) it carried the ventilation pipes around the main tunnel enlargement drilling, blasting and mucking operations, so that the gas and smoke from heading operations would not foul the enlargement operations.



Pioneer bores, cross-cuts, a centre heading for the main tunnel and radial drilling for enlargement are distinctive features of the construction

No Interference of Operating

It was thus possible to keep the heading progress, enlargement drilling, enlargement blasting, and mucking going simultaneously without any interference with one another whatever.

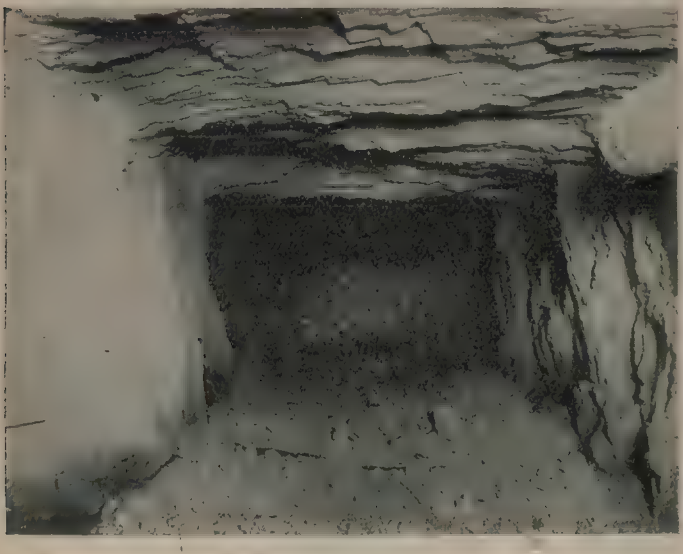
Before the main tunneling could be started a certain amount of preliminary work had to be carried out. On the east side, it was necessary to build three miles of temporary, heavy, side-hill railway, to reach the camp site and take out a rather heavy approach cut. On the west side about 1¼ miles of temporary railway had to be built and streams diverted before the approach cut could be started.

The pioneer tunnels, run from each end, were 7 ft. high and 8 ft. wide, and were normally 50 ft. to the right of the centre line of the main tunnel, with the bottom 7 ft. above subgrade. Thus, on the east end, the pioneer tunnel was north of the main tunnel, and on the west end it was to the south. The interval between cross-cuts varied from 1,500 to 3,000 ft., six cuts being driven from each of the temporary tunnels. The pioneer tunnels, working from each end, did not continue to a point of meeting, but were stopped at the sixth cross cuts, which were almost exactly one mile apart.

Pioneer Portals Modified

The normal alignment of the pioneer tunnels was modified at the portals to shorten them as much as possible. The east pioneer heading, which was started in September, 1915, was located about 50 feet north of the main tunnel, 700 feet west of the portal and about 60 feet above the main tunnel level. By so locating the pioneer heading about 700 feet of pioneer tunneling was saved and a quantity of soft ground work was reduced, and the work on the heading was started sooner than on the approach cut. The grade of the main tunnel heading reached the grade of the pioneer at the third cross-cut, two former cross-cuts being dipped. Solid rock was reached about 600 ft. in. At this point the first cross cut was started. The west pioneer heading was on an incline and was located about 700 feet east of the west portal and 150 feet above the main heading level. A grade of 50 per cent. was used to bring this heading to the main tunnel grade.

The reason that the pioneer tunnels were stopped at the end of the sixth cross-cuts was that it was rightly calculated that the advanced headings could be driven for this distance and that the drilling for the



One of the pioneer tunnel headings

Main heading Connaught tunnel, steam shovel at work

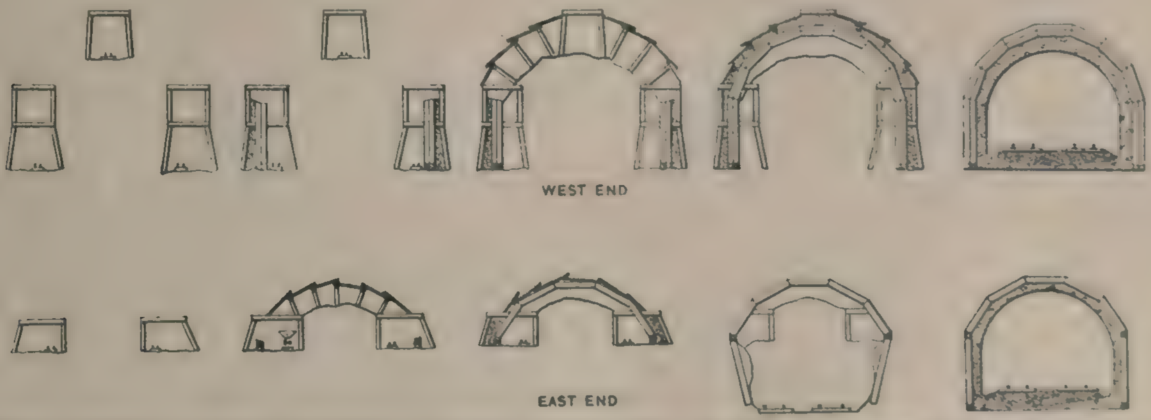
Approach work at eastern entrance

enlargement of the tunnel could be completed before the blasting operations would pass the last cross-cut and thereby disturb work within the limits of this mile of centre heading.

The main tunnel was located entirely in rock, with the exception of 1,200 feet at the east and 400 feet at the west end where it passed through loose debris consisting of disintegrated rock, loose rock and earth. In these portions special soft ground methods of tunneling were required, the process being to drive a crown heading with side drifts and full timbering. A description of the soft ground work was given in detail in the Contract Record of June 28, 1916.

Soft Ground Methods

The characteristic of this soft ground tunnelling was the adoption of a method that made the larger part of the excavation accessible for steam shovel mucking. At the east end, where there were 1,200 ft. of glacial drift, two wall plate drifts were driven and stoped out to make room for a five-segment arch timbering. The steam shovel operated by compressed air then excavated the core of the cross-section and everything below the wall plate, over 66 per cent. of the total excavation being removed by the shovel. Until the wall plate drifts met the main heading, the muck was drawn to the portal on 18-inch gauge cars. After that time the material was hauled to the first cross-cut and out at the pioneer heading. The stope material was passed down through a chute into the cars in the wall drifts. When excavating, the wall plate was supported on temporary batter posts which were set by the day shift, the following night shift straightening the face and setting the plumb posts and lagging. Although there were some doubts regarding the stability of the sides when the shovel was undermining the wall plate, it was found that the settlement at no time amounted to more than one inch. The wall plate drifts in this section were started in January, 1914, and reached rock in July. The entire excavation was finished in December, 1914.



Sequence of processes for soft ground tunneling. The aim was to make as large a part of the cut as possible accessible to the steam shovel

Difficult Work at West Entrance

At the west end, the soft ground section, amounting to 400 feet, comprised much looser material than at the east end, with a great many large boulders and considerable water. At this section, bottom drifts for the plumb posts were started first, with a view to drainage, followed closely by superimposed side drifts. The muck from the top heading was trapped into 18-in. gauge cars in the bottom heading. A crown drift was also driven, which was quite difficult due to the disturbance of the ground by the other drifts. After the plumb post drifts were finished, the plumb posts were set and a stope was started in the sides of the crown drift. A seven-segment arch timbering was employed. When the plumb post drifts had reached rock at the level of the top posts, wall plate drifts were used. The muck from the stopes was used to backfill the post drifts. While this method was very expensive in the use of timber, it allowed the steam shovel to excavate the entire core of the tunnel. Work was very slow and expensive, the time required for the 400 feet in this section being from June, 1914, to February, 1915. Owing to the manner in which the material at this section sets or hardens when drained, there was no caving in of the sides when the material had been removed from the inside of the plumb posts.

A Centre Heading for Main Tunnel

The rock portion of the tunnel was driven by using a centre heading 9 ft. high and 11 ft. wide, the centre line being the same as that of the complete tunnel and the bottom 8 ft. above sub-grade. The enlargement was made by drilling radially and blasting to full size, the position and size of the advance heading being such that the lateral holes could be drilled to break the enlargement to the required dimensions.

None of the rock was timbered except where local faulting occurred. There was some doubt as to the effect of the enormous rock pressure above the tunnel and the effect of eccentricity of load produced by the pioneer headings, but all fears proved groundless. The tunnel required no concrete lining except at the soft ground portions and a few rock sections where falls occurred due to slips in the rock strata.

Drilling and Mucking Operations

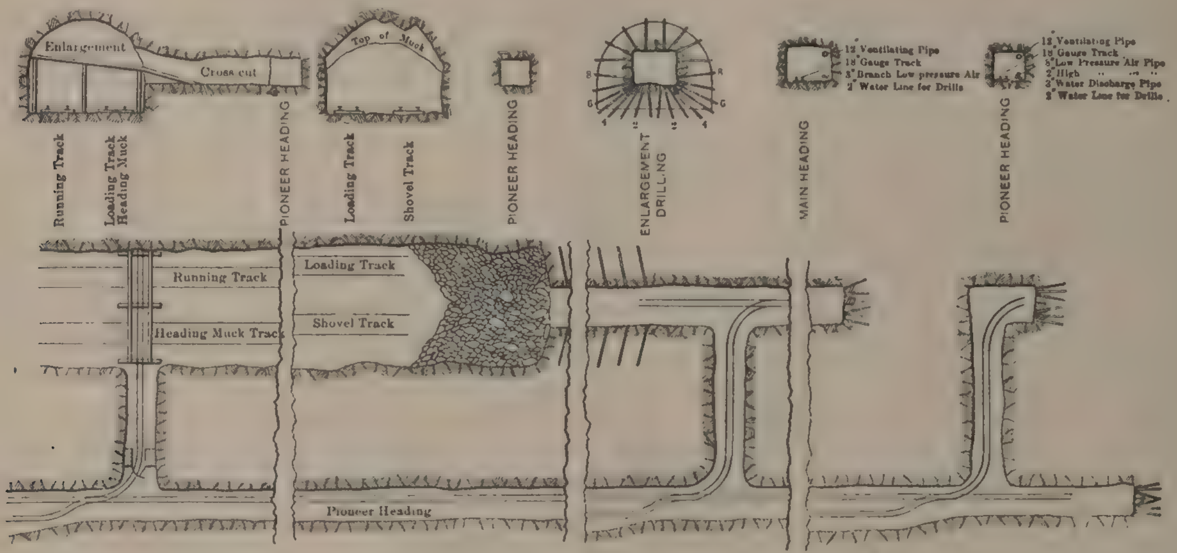
The pioneer and centre advance headings were driven with light Leyner hammer drills, using hollow steel with water attachments. As a rule three drills were used simultaneously in each heading with four, in hard rock parts, mounted on a light horizontal bar placed about 18 inches below the roof line. The idea of carrying the drills on a horizontal shaft held in place by heavy jacks was to enable these shafts and drills to be carried on narrow gauge tracks so they could be moved as required. This bar was first in position to drill all the holes in the upper half of the face and then in a lower position to reach the remaining holes. Air and water were taken over the muck pile or on hooks in the side by a single hose line for each to a manifold from which short individual hose lines supplied the drill. In the pioneer heading 24 holes were driven in the hard rock and 21 in the soft. In the advance heading 28 holes were driven in hard and 26 in soft. An advance of 6 or 7 feet was made per shot. The drills were always used on the upper position of the bar first, while the muckers were busy clearing away the muck below. This enabled the drills and muckers to work simultaneously with the least loss of time.

The muck was shovelled by hand from steel plates, upon which it was thrown by the blast, into one-half cubic yard dump cars operating on an 18-inch gauge track. The muck cars were taken back from the heading to a siding by a single mule and from there to the dump by a mule team, or where the haul was long, by a small compressed air locomotive. Material from the pioneer heading was carried along the pioneer tunnel to the first cross-cut behind the point where the main tunnel was enlarged to full section. Here it was hauled out on a trestle extending at right angles across the tunnel proper, by air hoist and cable, from which it was dumped into standard-gauge dump cars standing on tracks on the enlarged tunnel bottom. The advance heading muck was taken into the pioneer tunnel through the first cross-cut to the rear and was then disposed of as before.

Ventilation by Exhaust Fan

For ventilation, a 12-inch wooden water pipe was connected to a blower which was started exhausting when the first shot was fired or a little before. The men were enabled to get back to work in from 5 to 10 minutes. The pipe was hung on the side away from the track close up to the roof and was carried to within 20 feet of the face.

After each shooting, the drill gang followed the smoke back, at the same time trimming the roof, and set up the horizontal bar, placed their drills, and drilled the holes in the upper half of the face. There was rarely any muck to be handled before this part of the drilling could be started, as blasting of the previous bottom holes had thrown it well back from the face. When the drilling from the upper setting was completed, the machines were carried back and oiled and after the mucking was done the bottom holes were drilled, with the horizontal bar in its lower setting. While the bottom holes were being drilled the muckers laid the track, adjusted the muck sheets and brought up explosives. Spare drill machines were always kept at hand in the heading to replace those out of order.



The diagram illustrates the various operations in the construction of the tunnel in sequence.

The usual heading gang comprised three drillers, two helpers, five muckers and one nipper, working in three eight-hour shifts per day. The men operating locomotives or driving mules worked in two 12-hour shifts. There were always three men loading a car and pushing it out, while three others stood by with an empty car and rested until the load came out. This relieved the monotony of continuous shoveling, besides leaving an empty car available as soon as the load went out. The empty cars were lifted right off the track, so as to abolish the necessity of sidings.

Record Progress

The pioneer tunnel from the east was driven about two miles in one and a half years. The maximum monthly progress was 776 feet. The daily average was 20 feet for the entire drift in rock. The west pioneer tunnel was driven for a length of more than 1½ miles in less than a year. The maximum monthly progress was 932 feet, by long odds the record on the American continent. The daily average was 24 feet. In connection with the main tunnel heading, the average daily progress per heading at the east end was a little over 16 feet. The maximum monthly progress was 621 feet. At the west end the average daily progress per heading was 20 feet and the maximum monthly advance was 762 feet.

Radial Drilling for Enlargement

The enlargement of the tunnel to full size was accomplished by shooting a ring of holes drilled radially in a plane perpendicular to the axis of the tunnel. The rings of holes were 5 to 6½ feet apart, the maximum interval being used during the earlier work on the tunnel. The 5 ft. spacing was adopted when explosives advanced in price, since with the closer drilling, a saving in explosives was effected which was found to balance the extra cost of drilling. In addition the muck was broken into smaller pieces and scattered farther back. Each ring of holes comprised twenty-six holes. The drills of the Leyner and Dreadnaught types, which were so light as to be handled easily by one man, were mounted on arms on vertical columns. At each setting of the column the thirteen holes in one half of the ring were drilled. Two settings of the drill on the column were used, one to bore the upper holes and the other the lower. The column carrying the drill was always set at the same distance off the centre line of the tunnel and the arm for the upper and lower sets was always the same distance above the subgrade, the line and levels being furnished by the railway company's engineers.

Drills Set by Clinometer

To determine the correct angle for drilling the holes, a clinometer was employed when pointing the drills. This is a sheet iron plate 12 inches square with a handle riveted on the upper edge and a pendulum hanging from one of the upper corners. Graduations on the board show the angle at which each hole must be drilled and at the lower end of each graduation is a number showing the length of steel to be used in finishing the hole. The board was set on the shell or drill and the drill tilted until the pendulum reached the proper angle when the drill was clamped. A different board was used for each arm of the drill column. By placing drill columns with reference to line and grades and setting the drills by clinometer, irregularities in the heading driving did not affect the holes, which were always bottomed at a regular distance beyond the neat line of the completed enlargement. All setting was performed by men for that purpose so that drillers had only to do the drilling. The steel was also brought to the drillers and dull steel taken away. The normal drill setting was maintained except where the roof was soft, in which case the upper setting was lowered one foot so as to leave some trimming to be done by jack-hammers.

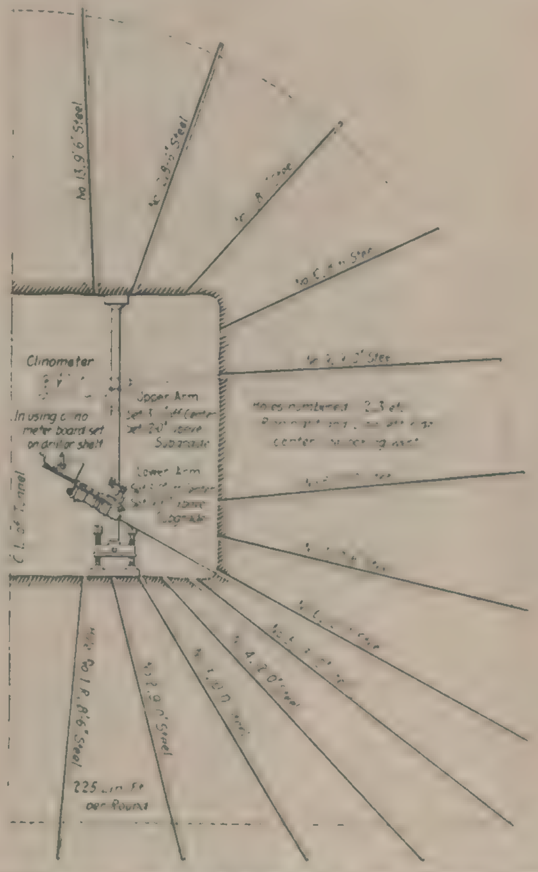
Remarkable Speed Possible

By using this ingenious method of enlargement a large battery of drills, as many as fifteen at one time, could be employed. Phenomenally rapid progress was the result, not only as to drilling, but also as to mucking, since the blasting out of the tunnel to full section with every ring of holes fired facilitated the use of the shovel.

The enlargement was carried on progressively from the two portals with the drilling work kept well ahead of the blasting and mucking so that air and water lines could be led into a cross-cut so as not to be interfered with by the blasting operations. Each drill completed three rings and then was moved to the head of the line taking the next three rings, air and water connections being made for every third ring. In this way congestion was avoided and no operator received benefit over another by having constantly softer rock to drill. A method of equalizing the work in this way was imposed by the system of payment. The drillers and helpers received wages plus a bonus if the footage based on a unit price per foot amounted to more than his wages. A peculiar feature was that new men, after a very few weeks practice made greater progress than long experienced men.

Centre Portion Drilled Complete

The mile of advance heading between the ends of the last cross-cuts from the pioneer tunnels was drilled for enlargement complete before any shooting was done within those limits. The drilling in this portion was started at the middle and progressed toward the portal, the track, pipe, etc., being removed as the drilling was finished.



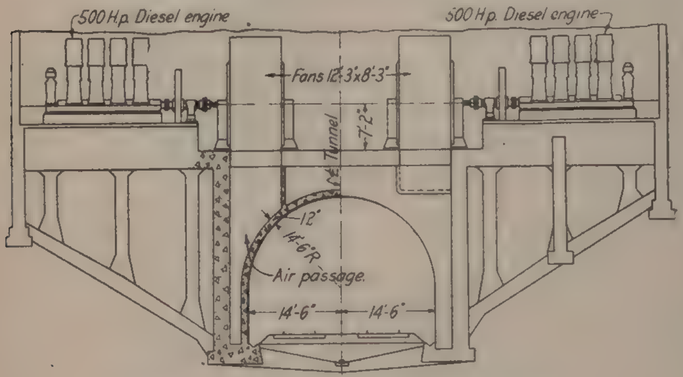
This enlargement was made by blasting in rings. The drills were set by clinometer to secure standardization.

The blasting was done with a battery in the main heading. The holes in the lower half of the section were shot in advance of those in the upper half. The shooting was usually continued until the tunnel became so full of muck that no more shooting could be done. The steam shovel then cleaned up the muck, after which blasting was resumed. When no holes had to be reloaded rings could be blasted at 15 or 20 minute intervals. Jack-hammers were used after removing the muck to drill up tight rock that did not blow off to the neat line. If a hole did not break, it was reloaded and shot with the next ring.

To get the bottom to break to sub-grade, it was found necessary, when the tunnel was started, to drop the floor of the main heading one foot and drill one foot deeper. Relief holes, sometimes as many as eight, had to be used in tough breaking rock to get the sides below the springing line to break to the full width.

Ventilation Methods

To remove the gases and smoke, fresh air forced in by a fan at the portal circulated through the pioneer tunnel and cross-cut ahead of the blasting and then back through the main heading over the muck pile and out at the portal of the main tunnel. Stoppings and doors in the cross-cuts passed by the shovel prevented the circulation from short-circuiting. Ventilation in the blind ends of the advance and pioneer headings was furnished by auxiliary fans set up in the pioneer tunnel to exhaust air from the headings through a 12-inch wood stave or galvanized pipe.



Section Through the Ventilating Plant

The enlargement mucking was done with a steam shovel adjusted to operate on compressed air, loading into standard gauge 12-yard air-dump cars. The shovels had dippers of 1½ cubic yard capacity. The tunnel being large enough to accommodate two standard-gauge tracks, the shovel operated from one track while the muck cars were backed in alongside on the other, by two small compressed air locomotives. A larger high-pressure compressed-air locomotive in each end took care of the haulage to the portal. They have a storage capacity sufficient to carry them one mile with a regular load, and 2-inch high-pressure air mains in the tunnel provide air stations about 2,000 feet apart.

The shovels mucked on an average about 2 feet per hour. The best monthly run for one shovel was 986 feet at the east end and 1,030 feet at the west end. The shovels were working at such a rate as to complete four miles of tunnel per year.

The force for mucking out each end was as follows for each shift: 6 men scaling, trimming and loading rounds ahead of shovel; 1 engineman and 1 craneman on the mucking shovel; 10 to 12 pitmen at the shovel; 1 general foreman; 1 foreman and 12 to 15 laborers for the dump and track work; engineers and brakemen, 1 fireman, 1 steam conductor and 2 repair carmen for the hauling locomotives and cars.

Concrete Lining for Some Parts

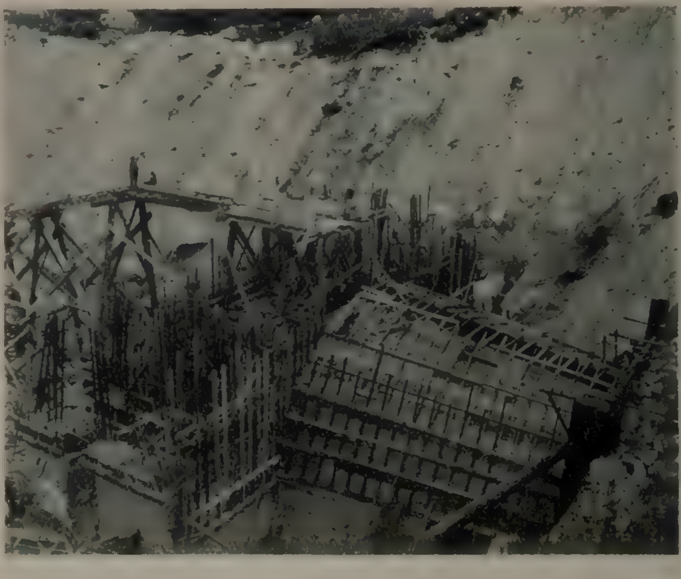
About 1½ miles of the tunnel required a concrete lining. This included the soft ground sections at each end and interior sections where the rock was of a disintegrated character requiring a covering. The concrete was applied to about 6,000 feet, extending in from the west portal, and 1,300 feet from the east portal, with a little over 600 feet at intermediate points. The concrete section is heavily reinforced, which prevented the use of the pneumatic method of placing. There is no invert in either the rock or timber portions, a simple wall footing being set to sub-grade offset 6 inches from the neat work line on the inside. The minimum thickness of the lining was 2 ft. 6 ins. in the soft ground and bad rock sections and 15 ins. in places where the rock is firmer. Where an overbreak occurred the lining required back as well as front forms, the concrete being applied to standard thickness, and the space behind the back forms was filled with rock to the springing line and cord wood above that level.

The reinforcement consists of ¾-in. circumferential rods placed concentrically 12 ins. centre to centre and ½-in. longitudinal rods 2 ft. 6 ins. centre to centre. The side walls were united to the arch by dowels.

The forms were of wood with ribs placed 4 ft. centre to centre and 16-ft. lagging assembled in widths of 3 ft. by means of cleats. For the keying of the arch 4-ft. lagging was used for a width of 2 ft. 6 ins. at the crown. This permitted the placing of the keying in short sections. The arch ribs were secured in place by anchor bolts set in the rock, wires from these bolts being secured to lines of 6 in. x 8 in. wales.

Special Car Mixing Plants

Mixing plants located outside of the tunnel placed all of the lining at the east end and 2,300 feet at the west end of the tunnel. Special car mixing plants were used for the lining elsewhere. This plant consisted of three cars, one containing the mixer, one the gravel and one being an incline car. The hopper cars supplied the gravel which was deposited in a small car running on a track on the floor of the cars underneath the hoppers. This gravel car carried the material to the mixer car which contained a complete plant for the proportioning, mixing and discharging of the concrete. The purpose of the inclined car, which consisted of a flat car upon which an inclined track had been built, was to transfer a concrete buggy with its load of con-



West entrance to tunnel. Ventilating plant is located at this portal.

crete from the track level to a track on an elevated platform supported by the forms. This platform supported at a level of 15 ft. 8 ins. above sub-grade received the concrete from the mixer. It was placed in the forms by hand. Both concrete and material cars were operated by cables from the drums of hoisting engines located on the mixer car.

To facilitate the delivery of concrete a 32-ft. length of traveling platform supported on trucks was installed on the fixed platform and moved along on the latter as the work progressed. This supplementary platform was equipped with a track on the centre line elevated about 3 feet, save for an incline at one end to connect with the track on the platform proper. Along each side of this track and extending to the side walls, inclined aprons were installed on which the concrete, dumped from the cars, was scraped into the side wall forms, or picked up in shovels to be thrown back on the arch forms.

Ordinarily the concrete crew worked a single 10-hour shift during the day time. Night work consisted of backfilling and packing, carpenter work on the forms and preparation of the mixing plant for the next day's run. A day's supply of cement was piled on the roof of the concrete car. Forms for 400 ft. of tunnel were usually in place at one time and 48 ft. of completed side wall was kept in advance of the arch to permit the erection of arch centres.

Sixteen men were commonly employed on the platforms to deposit the concrete. Work was concentrated on an arch section, placing the lagging as the level of the concrete rose. As the crown was closed up and the work slowed down the concrete could not be placed as fast as the mixer could furnish it. Consequently, a portion of the crew was diverted to place the surplus concrete in the side walls, while the remaining force completed the keying of the arch. The crew on the mixing plant consisted of 15 or 16 men. In the absence of traffic in the tunnel it was possible to carry on this work to good advantage and the progress was rapid. In ten consecutive days an average of 200 cubic yards of concrete was placed per shift.

As soon as the preliminary work enabled the track to reach the sites, complete construction camps were built at each portal with accommodation for 500 men at each end. These were completed about the end of 1913. They embodied every comfort and sanitary convenience for the men, including hot and cold water, steam heat, sewerage and electric light.

The power plants at the camp sites supplied compressed air, water, electricity and heat for the buildings. Five 150 h.p. return tubular boilers with induced draft and special grates for slack coal provided steam. The boilers were generally operated above capacity. Each plant had three compressors supplying in combination 4,500 cubic feet of free air per minute at 100 to 125 lbs. pressure at the compressor and 90 to 100 lbs. at the drills. Two high pressure compressors with a combined capacity of 1,500 cubic feet per minute provided air at 1,000 lbs. pressure at the compressor and 800 to 900 lbs. at the charging station, this air operating the locomotives. The low pressure machines were two stage and the high pressure, four stage with intercoolers, the steam ends being compound condensing. An after-cooler was added to prevent trouble from the freezing of the moisture in the air exhausted by the appliances. The compressors were of the Ingersoll-Rand pattern.

All locomotives operating in the tunnel headings used compressed air. In each pioneer tunnel a 5-ton locomotive on an 18-inch gauge track hauled the small muck cars from the headings. At the west end three 15-ton standard gauge locomotives handled 12 cubic yard Western steel air-dump cars. At the east end where the grade was down, three 10-ton locomotives were used in similar service.

Trains Through Tunnel Operated by Steam

Although it was the intention at first to operate trains through the Connaught Tunnel electrically, the high cost of installing plant, which would wipe out any saving due to the construction of the tunnel, decided in favor of steam. This implied the installation of a high power ventilating plant by which air is blown through the tunnel by fans, so that steam locomotives may be used with perfect safety. The fans are located over the west portal and are direct-driven by Diesel engines. They force air down the tunnel against the ascending train. They are not used for trains descending the grade. The air is forced into a comparatively large chamber which terminates in a nozzle inside the tunnel, the air coming out at a high velocity, sufficient to blow away the smoke. The two fans are 12 ft. 3 ins. in diameter and 8 ft. 3 ins. wide, capable of delivering, in combination, 700,000 cubic feet of free air per minute at a temperature of 70 degrees. These were made by the B. F. Sturtevant Company of Canada, Limited, Galt, Ont. Diesel engines for driving the fans are two in number, four-cylinder, four-cycle, 500 h.p., manufactured by the McIntosh & Seymour Corporation. Each weighs 156,000 lbs. and operates at 190 r.p.m. These engines consume only 0.4 to 0.5 lbs. of oil per h.p. hour, as against 2 or 2.5 lbs. of oil for a boiler. The results will perhaps be even better than this, as the work is only intermittent, the fans being run only at intervals when a train is on the upgrade through the tunnel and for a sufficient length of time after the train passes to entirely clear the tunnel of gas. The engines are direct connected to the fans and to a three-stage air compressor, compressing to about 900 lbs. pressure.

The east portal of the Connaught tunnel.

The air from this is supplied to two receivers and is used to start the engines. The locomotives used on this section of the railway burn California crude.

The Permanent Track

The laying of the permanent track in the tunnel was simplified by the presence of the contractor's standard gauge track throughout the entire length. Tunnel rock was found unsuitable for use as ballast, so a pit-run gravel from Revelstoke, 43 miles west of the tunnel, was used. This was delivered in Hart ballast cars, and was handled into the tunnel from the uphill and by compressed air locomotives in two to six-car trains, the loads going down hill and being plowed off in the same direction. The ties and rails were handled in the same manner. All work was done by the contractor with a gang of about 100 men. Drainage of the road bed is afforded by an 8-inch tile drain located on the centre line between tracks at sub-grade.

Auxiliary facilities in the tunnel include refuges in the sidewalls at intervals of one-quarter mile and a telephone every half mile. The tunnel telephone line and a 1¼-in. cable for the regular telephone and telegraph circuits are carried in a wooden duct buried in the ballast on the centre line between tracks. A turntable is provided at each end of the tunnel.

A Bonus System Secures Speed

The tunnel has been finished eleven months ahead of contract time and for a substantial sum less than the price bid. The contract for the work was let on July 1, 1913, with the time of completion set as three and a half years, which ended on January 1, 1917. There was an allowance of one day for every 10 feet of soft ground encountered and as there were some 1,660 feet of such ground the time was virtually extended to June 1, 1917. The contract did not include track laying, ballasting and surfacing. A bonus was provided in case the tunnel was completed in advance of the date fixed, the time fixed for the calculation of the bonus or penalty being when the contractors had completed the enlargement of the main bore. This was done when the shovels met on July 6, 1916, eleven months ahead of time. The contractors also established a bonus system of payment for the men as an inducement to increase the rate of progress. The men of each heading gang were paid by a combination of day rate, piece work rate, and bonus. Each gang received a piece work rate of $2.00 per foot in the advance heading and $1.50 per foot in the pioneer heading, this being divided among the men of the gang in proportion to their daily wages. If in any month the total amount of heading driven exceeded 450 feet, the gang received a bonus for each foot in excess of the 450 feet, the bonus being divided among the members of the gang. The above rates were based on tunnelling in schist, quartz or quartzite tunnelling being arranged on the basis of 1 foot of quartzite being equal to 1½ feet of schist. In a case of steam shovel work for the removal of the muck from the enlargement, 750 feet of tunnel was regarded as a standard month's performance with a bonus provided for each foot of excess completed per month.

Personnel

The general contractors for the tunnel were Foley Brothers, Welch & Stewart, the construction being supervised by Mr. A. C. Dennis, M. Can. Soc. C. E., their superintendent. The Canadian Pacific Railway Company performed the necessary engineering work. The company's staff comprised Mr. J. G. Sullivan, M. Can. Soc. C.E., chief engineer; Mr. W. A. James, M. Can. Soc. C.E., engineer of construction; Mr. F. F. Busteed, M. Can. Soc. C. E., engineer of double tracking; Mr. H. G. Barber, assistant engineer; Mr. T. Martin, and Mr. J. R. Macredie, resident engineers.

Coloring Concrete

THE monotony of concrete construction may often be diversified and ornamental effects easily secured by application of simple pigments to cement before mixing. The permanency, of course, is an important consideration for this work, and a number of the best colors suitable for it are enumerated in a bulletin on cement stucco issued by the Association of American Portland Cement Manufacturers. The quantities recommended will give a light shade of the desired color. About twice as large a quantity is necessary for a medium dark shade of the same color.

Mix the coloring matter thoroughly with the sand till a uniform color results and then mix with the cement. Blacks are safe colors, as a rule, but it is better to avoid experiments with cheap blacks. The carbon blacks are preferable to lampblacks, because they do not have the same tendency to float to the top during mixing. Utra-marine blue, if of good quality, will hold its color for a number of years, and generally possesses the virtue of fading out evenly. It cannot be classed as a permanent color, as is black, brown or ochre.

Green is an unsatisfactory color to experiment with. Commercially, there is no green cement color on the market that will not fade when mixed with cement and exposed to light and weather.

COLORS REQUIRED	PIGMENTS USED	Pounds of Pigment for Each Bag of Cement
Grays, blue-black and black	Germantown Lampblack Carbon Black Black Oxide or Manganese	½ ½ 1
Blue shade	Ultramarine Blue	5
Brownish-red to dull brick red	Red Oxide or Iron	5
Bright red to vermillion	Mineral Turkey Red	5
Red sandstone to purplish red	Indian Red	5
Brown to reddish-brown	Metallic Brown (Oxide)	5
Buff, colonial tint, and yellow	Yellow Ochre	

Stratford Builders' Exchange Have Banquet

On the evening of May 8, the annual banquet of the Builders' Exchange of the city of Stratford, Ont., and the County of Perth, was held at the Mansion House, Stratford. Mr. Clove Myers, president of the Exchange, was in the chair, and a pleasant and profitable evening was spent. The program was informal, nearly all present taking part. The city was represented by Mayor Monteith and also by Inspector Geo. Heideman and Assistant Inspector Dixon of the building department. Thoughts of the war, as usual, were present to the minds of all, and a toast was proposed to "Our Overseas Members," particular reference being made to Lieut.-Col. John L. Youngs and Lieut. John Keyes, two prominent builders who are serving their country in France. It was stated that Col. Youngs recently resigned his rank to get back to the line of battle, where a few weeks ago his son, Lieutenant J. L. Youngs, gave up his life.

The steel sash contract for the Middlesex Mills Company has been awarded to the A. B. Ormsby Company, Ltd., Toronto.

A Ten Storey Warehouse

In Montreal—Flat Slab Concrete Construction with Stone and Brick Exterior—Excavation Started

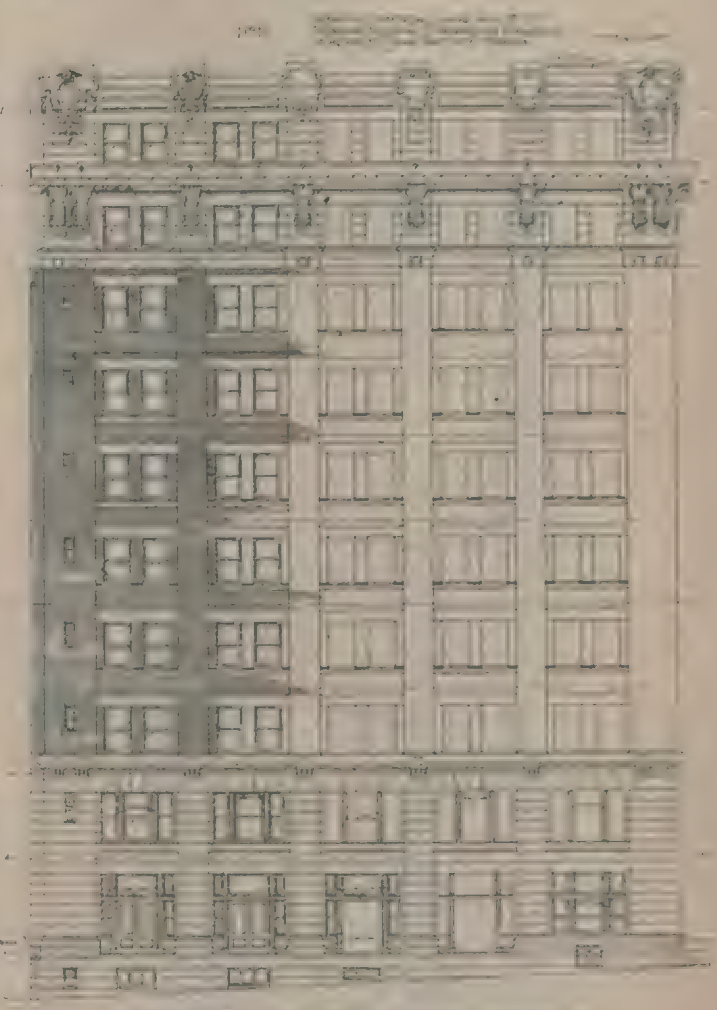
EXCAVATION has been commenced for a ten-storey storage warehouse, designed by Mr. A. Piche, architect, Montreal, for the Greater Montreal Land Investment Company. The site is at the corner of St. Lawrence Boulevard, St. Jean Baptiste Street and Le Royer Street, the frontage being 92 feet on two sides and 68 feet on the third side. The building to be constructed, on the loft principle, is 130 feet high, and is intended for the storage of valuable merchandise, but later it is hoped to use it for an office building, very few alterations being necessary for this purpose.

The foundations are of reinforced concrete, while the exterior will be of Ohio cut stone for the first two storeys, plastic brick for the next six, and cut stone for the remaining two, with a certain amount of ornamentation in the way of carving and moulding. The structure generally is to be of the skeleton reinforced concrete type, flat slab construction, with the floors designed to carry 250 pounds per square foot live load. The ceilings and interior walls are to be of cement finish. The stairway will be iron-cased, with wired glass and steel sash. Lavatories will be provided on each floor, the walls and floors being of tile and the partitions of marble. The roof is of tar and gravel. A sprinkler system, with the pressure tank on the same level of the roof, is to be provided.

One passenger elevator and two freight hoists will be installed, and in addition there is to be a lowerator for lowering goods, which consists of a platform operated by an endless chain. This device will lower goods only—it cannot be used for hoisting purposes. Heating will be by means of a low-pressure steam system, the boilers and other equipment for this purpose being located in a basement.

Three entrances will be provided, with the main one on Le Royer Street. This is approached by granite steps, leading to a vestibule with tiled floor.

The general contractor is Mr. L. Beaudry, Montreal. The contract for the elevators has been awarded to the Otis-Fensom Elevator Company, Montreal; the lowerator to the Lowerator Company, New York, and the plumbing and heating to Latourelle & Co., Montreal.



Architect's drawing of a 10 storey concrete warehouse on Le Royer Street, Montreal.

The Tallest Chimney in the World

Recently Completed in Japan—Reinforced Concrete, 570 Feet High, Over 26 ft. Inside Diameter at the Top—Smoke Flue 2,500 ft. Long

By Chas. P. Woodworth*

THE chimney illustrated below, which was constructed by the Weber Chimney Company at Saganoseki, Japan, for use in connection with copper smelting furnaces, is the highest chimney in the world. It is 570 feet high above the base, 42 feet 8 inches outside diameter at the bottom, with an inside diameter at the top of 26 feet 3 inches. The shell thickness is 29½ inches at the bottom and 7 inches at the top. It is designed to withstand earthquake stresses, the design being checked and approved at the Tokyo Imperial University. The reinforced concrete foundation, of monolithic construction, rests on gravel on top of a hill 430 feet above sea level. The maximum bearing pressure per square foot under maximum wind conditions is 6,000 pounds per square foot. The foundation is in the form of a truncated cone 17 feet thick, with a diameter of 95 feet at the base and 42 feet at the top. It contains 2,711 cubic yards of concrete, and required 30 days to place, working 24 hours a day. The total steel reinforcement in the structure amounts to 530 tons, and consists of plain, round steel bars and square bars of American make. This steel was purchased in Japan from stock. The reinforcement consists in the lower portion of the chimney of pairs of rings of ⅜ in. square bars, spaced 6 in. centre to centre vertically. In the upper portion there are single ⅝ in. rings, spaced 7½ in. centre to centre. The chimney has a reinforced concrete lining to a height of 150 feet above the top of the foundation. The lining and shell are separated with a 4 in. air space.

The Portland cement used was of Japanese manufacture, and equally as good as American makes. The mixture in the shaft was 1:2½:4, with 1 in. stone. The foundation mix was 1:3:5, with 2 in. stone. The chimney was built in courses 5 ft. high, and two sets of wooden movable forms were used, which allowed for leaving forms in place 24 hours after the concrete was poured. An idea of the size of this chimney can be gained from the fact that the lower 5 ft. course contains enough concrete to make a 6-ft. chimney 120 ft. high.

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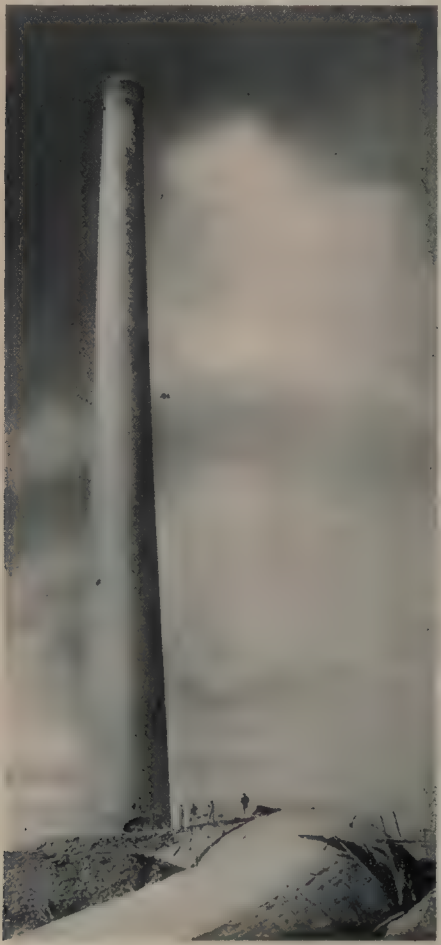
* Vice-President, Weber Chimney Company.

The mixing and placing equipment comprised a one-yard Smith mixer and a steel hoist with elevator bucket and wooden tower built up inside the chimney. An aerial wire tramway 5,000 ft. long was used to deliver all materials. Two of the officials of the Weber Chimney Company and eight other Americans in the employ of the contractors were sent to Japan to build the chimney. Native labor was employed, and found to be cheap but inefficient.



The world's largest chimney, here illustrated, is 570 ft. high.

A reinforced concrete smoke flue extends from the smelter plant to the chimney, a distance of 2,500 feet up the slope of the hill. It is of elliptical section, 30 ft. across the larger diameter, with a wall thickness of 8 inches. It is built on a zigzag line, so as to form a series of baffles to check the flow of gas and cause the dust to settle. A manhole and interior stairway provide access for collecting and removing the dust. At the base of the chimney is an opening 20 ft. wide and 31½ ft. high, from which a horizontal conduit 20 ft. long is built integrally with the chimney. The bottom of this opening is level with the top of the foundation, and the smoke flue is connected to it.

For the purpose of lightning protection there is a copper circle at the top of the chimney, which has seven platinum points extending 4 feet above the edge of the chimney. From this circle seven cables lead to the base. At a height of 400 feet from the base a similar copper circle, with four platinum points, is located, with rods down the chimney.

The general contractors for the smelting plant were the Oriental Compressol Company, the Weber Chimney Company designing and erecting the chimney for the general contractors

Repairing Destroyed Bridges

In French Battle Areas—Stone Structures Repaired with Concrete Without Use of Falsework

THE exigencies of battle in the north of France have required the rapid and stable reconstruction of a number of masonry arch bridges that had been more or less completely destroyed by the German or by the Allied forces for military reasons. These bridges are generally in an area where timber and cut stone are scarce, and their reconstruction must be done rapidly without the aid of the needed quota of skilled artisans. To meet these conditions, concrete arches placed without the use of falsework have been successfully employed in a number of cases.

Cement, of course, can more readily be brought forward than any other structural material, and sand and gravel are local products, so that concrete, which can be made by unskilled labor, is doubly effective for such work. A novel feature of the reconstruction, however, is the use of old iron and a minimum of timber for arch centers, which can be readily erected, thus saving time and labor. As a rule, these centers are of old steel rails, curved to an arch immediately below the main arch rib and carrying the concrete of that rib on a supplementary thin concrete arch cast on a timber frame supported from the rail ribs.

This article, taken from Engineering News-Record, outlines the reconstruction of one such bridge according to this method, the details of which were described in Le Genie Civil for April 7, 1917. This bridge is one across the Meurthe River and was rebuilt by the railway company that operated the two-track line crossing it. The bridge, shown in Fig. 1, originally comprised three 60-ft. masonry arches, of rather low rise. Two of these were completely destroyed, as shown in the drawing.

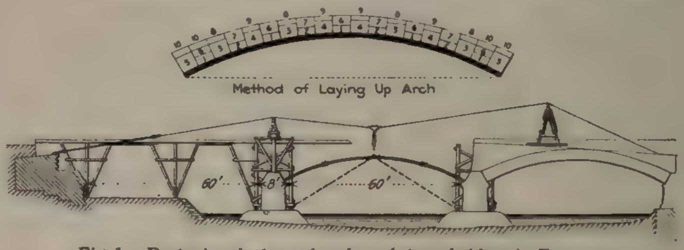
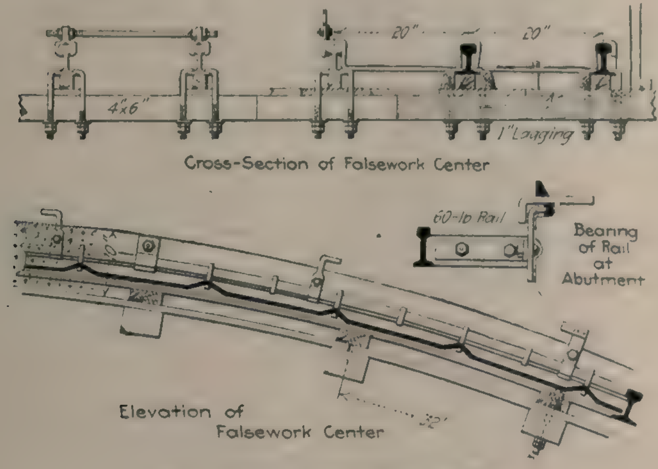


Fig. 1.—Restoring destroyed arches of stone bridges in France.

The first operation was to build the light timber framework carrying the footway and erect thereon the towers for a construction cableway. From this cableway a series of centering ribs made up of old steel rails was placed. These rails, which were found in the neighborhood, weighed 60 lbs. to the yard. They were cold bent to the proper curve, in two sections, as shown, and spaced 20 inches centre to centre clear across the arch. At the abutment they were bolted to a bedplate that was held by a hook bolt driven into the masonry. These curved rails were used as the basis of a thin concrete arch that in itself served as the centre of the main arch. This procedure was adopted rather than placing the main arch immediately upon falsework hung from the steel ribs themselves, because the rails were not sufficiently strong to act as centers.


Cross-Section of Falsework Center

Elevation of Falsework Center

Fig. 2.—Details of steel-rail arch centering.

The details of the centering are shown in Fig. 2. It consisted merely of timber joists and a floor hung by steel rods from the old rails. On this a concrete arch rib of 1:2:4 concrete was placed for a uniform thickness of 10 in. from abutment to abutment and for the full width of the arch. This concreting was done in two parts, a crown section and two abutment sections being first placed and the intermediate sections last. The whole concreting of this shallow section could be done in one morning. Ten days was allowed for this concrete to set. Meanwhile the top of the rib was laid off in 19 voussoirs, and a vertical dividing wall was erected across the arch at each voussoir division line. This dividing wall was made of a wire mesh, large enough to hold the aggregate, fastened to ¾-in. and ⅝-in. vertical rods tied in at the bottom to hook bolts that had been left emerging from the centering concrete. These frameworks having been placed during the ten days allowed for the setting of the centers, concreting was carried on across the arch rib in the voussoirs so laid out, placing them across the bridge so as to impose the least eccentric loading on the centering arch. The progress of voussoir deposition is shown in Fig. 1. All this concreting for one 6-ft. arch could be done in two ten-hour days.

After the main arch rib has achieved a sufficient set, the centering arch can be removed, although this is not necessary. Meanwhile, the superstructure of the arch can be erected in a continuous process following the construction of the main arch rib and the roadway put into service in a minimum of time.

Standardized Steel Frame Construction

Standard Units Have Been Designed to Simplify and Facilitate Erection of Steel Structures—Tests Show Great Strength

In steel work construction on the usual methods of manufacture a large portion of the time required for production is occupied in design and calculation, the preparation of working drawings and details, the listing of parts, and making templates. Repetition work of this description represents valuable time lost, quite irrespective of the question of expense, which may be avoided by the adoption of the standard unit principle, with which this article, from the "Engineer," deals. When post-war conditions prevail, a vast amount of work which was suspended owing to war demands will be proceeded with, and any system which will expedite and reduce the cost of building construction is worthy of consideration.

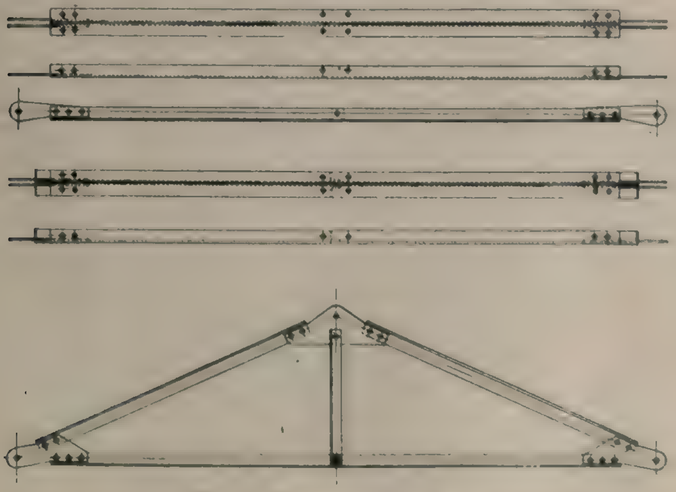


Fig. 1.—Standard units and parts.

Simplifies Erection

Standard units have been designed to simplify the erection of every description of steel structure, and at the same time to provide maximum strength and safety. The units are triangular in form, constructed of steel angles, which are bolted or riveted to steel plate corner gussets. The joint holes for the reception of a large diameter bolt are drilled in each gusset at the exact intersection of the central lines of the triangle sides. The bars are of steel angle section, and are provided with joint plates bolted, or riveted, to angle, and shaped out to accommodate the joint hole on the centre line of bar for connecting up to the units in the structure. The flanges of units and bars are provided with standard holes for connection of purlins, rails, or bracing bars in the structure. All the various members are manufactured to standard templates, dies, and gauges, the units and bars being assembled on a stiff frame of exact gauge, thus ensuring correctness of dimensions when the gusset plates are bolted up, and eliminating any slight inaccuracies of workmanship. The units and bars are also constructed in doubles, for the purpose of providing greater strength. Particular members of the lighter frames may be reinforced by the addition of standard bars.

Simple Connections

The structures are pin-jointed, providing the simplest possible connection, and the joint bolt is of sufficient shearing strength to develop the full stress that can be taken in the members of the unit frames or bars.

The system is, therefore, admirably adapted for the construction of either permanent or temporary buildings of a light or heavy nature. It is also specially applicable to semi-permanent or emergency buildings which can be readily dismantled if desired and erected on a different site, whilst the style of building can be altered or modified by the addition of further units. By a suitable combination of standard units and bars, spans are obtained from 10 ft. to 50 ft. in closely graduated steps, and larger spans up to about 100 ft. are obtained by building the standard frames or girders running crossways of the structure and carrying the roof covering on small cantilever trusses built up of single units and bars. The additional strength for the larger span girders is obtained by providing flange plates fixed through the standard holes in the units. An important advantage claimed for the standard unit system is the saving in cost and time in erection, as the interchangeability and accuracy of the standard parts ensures rapidity of assembling. The standard bars and units are bolted, or riveted, up at the makers' works ready for immediate erection on delivery, and the dimensions are such as to provide for convenient handling and transit.

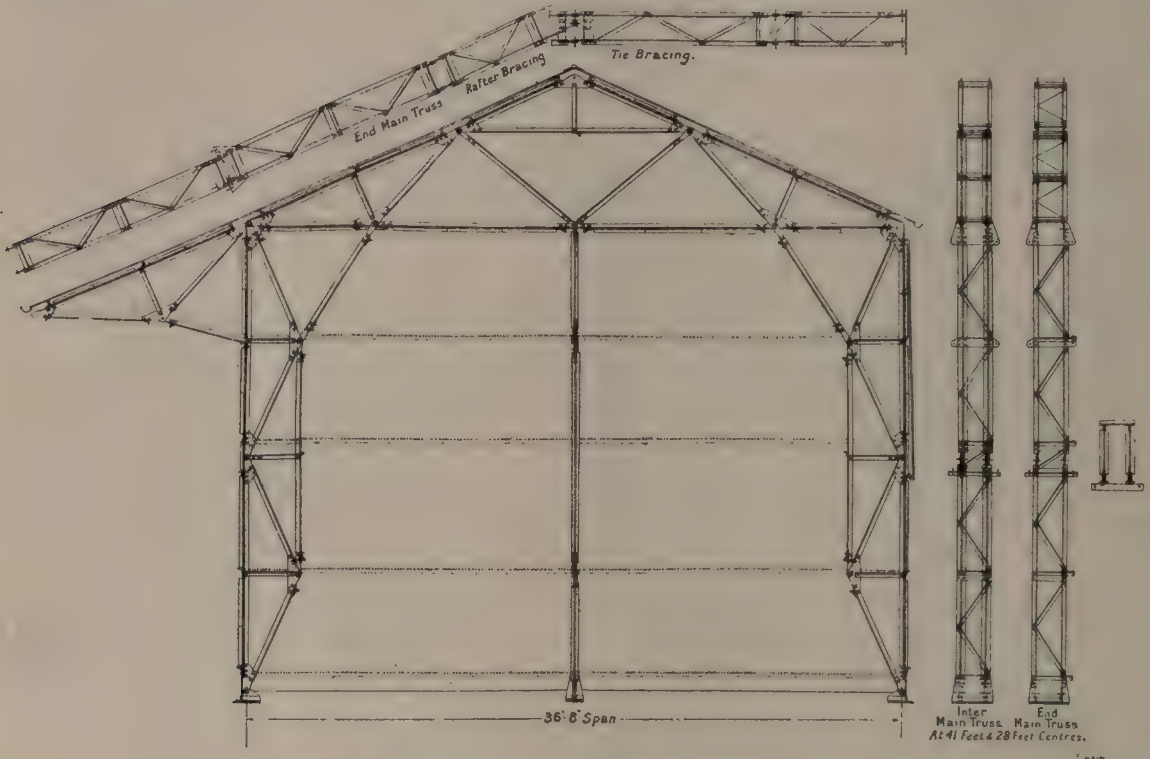


Fig. 2.—Cross section of a building erected with standard steel units.

The connections of the standard parts require only one large diameter bolt for each joint.

A single 13 ft. standard unit of the lightest section, under test, carried safely a load of 4,872 pounds, hung from each side, and in addition a central load of 1,568 pounds, making a total of 11,312 pounds. At the same time various other tests were carried out on riveted and bolted unit frames of single and double members, each arrangement of loading being supported safely by the standard unit. Loads of one ton each were hung from the pins on the base intersection of the single 13 ft. unit frame, the base member being unsupported externally between the pins.

The same loads were hung from cleats fixed to the end standard flange holes in the base member of the single 13 ft. standard unit, thus testing the effect of this eccentricity of loading. Similar tests were made on the single 10 ft. standard unit with the same loads. Loads of five tons each were also hung on the similar pins of a double 13 ft. unit, the total load being the safe lift of supporting crane.

Fig. 1 applies to a building constructed on the standard unit principle. Unit frames are employed throughout the structure in columns, roof trusses, eaves, girders, and lateral wind-bracing girders.

Table of Safe Stresses

Tensions—8 tons per square inch net area.

Compression $\dfrac{7}{1+a\,(1/k)^2}$ per square inch gross area.

$a = \dfrac{1}{10{,}000}$ for pin ends and $\dfrac{1}{20{,}000}$ for flat ends.

Shear on rivets—6 tons per square inch.

Shear on bolts and pins—5 tons per square inch.

Double shear on rivets, bolts, and pins—1.75 times single shear.

Maximum fibre stress on pins in bending—11 tons per square inch.

Bearing pressure—12 tons per square inch.

As regards dimensions and clearances the design adopted fitted exactly the requirements of a rather difficult site, where the sidings and surrounding structures were already built. The building is 111 feet long by 26 feet high by 36 feet 8 inches wide, with an overhang on the one side of 12 feet, the columns being spaced at 41 feet longitudinally to suit the requirements of the site. Standard units of 13 feet were employed throughout, either single or double, as required for purposes of strength.

With regard to the properties of standard units and bars it might be mentioned that the standard unit has a base of 13 ft. centre to centre of pins, and the secondary standard unit has a base of 10 feet to provide in combination with the 13 feet unit for a greater variety in dimensions. The standard bars are made of lengths as required, the straight lengths of angle being cut and punched with standard holes for attachment to the standard gusset plates at each end. The allowable safe stresses on mild steel for the various unit members are given in the table.

Cement Concrete Roadways of Ontario

A Detailed Schedule of All Pavements of This Type Laid in the Province — Over 1,500,000 Square Yards

By T. Harry Jones*

(Continued from last issue)

Sarnia

Total number of square yards of one course, 10,571; constructed by Ontario Highways Department in 1913 on main artery to the town; length, 5,946 ft.; width of concrete, 16 ft. with 4 ft. gravel shoulders on each side; depth, 7 in.; mix, 1 of cement (10 per cent. by volume of hydrated lime) to 4 of gravel. Cost per square yard, $1.54.

Simcoe

Total number of square yards of one course, 2,475; thickness, 9 ins. at centre, 6 ins. at gutter; mix, 1:2:3; width, 48 ft.; not reinforced; centre joint; no cracks have developed. Average cost, $1.45, including grading. Laid in 1916.

Sault Ste. Marie

Total number of square yards of two course, 19,700; base, 5 in., mix, 1:5; top, 2 in., 1:2 screened gravel fine to 1/3 in.; average cost, $1.37, including grading (without overhead charges); number of square yards laid in 1916 (two course), 10,700; same as above; no reinforcement used. First concrete pavement laid in 1914.

Stratford

Total number of square yards of one course, 6,400; thickness, 5 in. at curb, 7 in. at centre; mix, 1:1½:3 (crushed stone); reinforced with No. 7 triangular mesh and Kahn joints; 99 per cent. of blocks free from cracks, which is remarkable considering sub-grade. This pavement laid in 1914.

Stamford

Total number of square yards of one course, 2,050; thickness, 6 in.; mix, 1:2:4; cost, $1.47 (labor 15c per sq. yd.); no reinforcement used; 80 per cent. of blocks free from cracks. This pavement laid in 1913.

St. Jacobs

Total number of square yards of one course, 4,392; thickness, 7 in.; mix, 1:4; average cost, 97 cents; square yards laid in 1916 (one course), 1,777; thickness, 8 in.; mix, 1:4; no reinforcement; very few cracks; makes a good road.

First concrete pavement laid in 1913.

St. Thomas

Total number of square yards of one course, 22,160; thickness, 7 in.; mix, 1:1½:3 stone; all reinforced; average cost $1.50; first concrete pavement laid in 1913. Street car tracks laid in 1914. Sub-grade 9 ft. wide, with 4½ in. concrete of 1:1½:3 (stone) on which ties and rails are laid and concreted to top of rails.

Steelton

Total number of square yards of two course, 8,866; base, 5 in.; mix, 1:5 (gravel); top, 1½ in.; mix, 1:1:1 (granite screenings); laid in 1912.

Toronto

Total number of sq. yds. laid since 1895, 144,243.

Number of square yards laid in 1916 of one course, 2,837; thickness, 6 in.; mix, 1:1½:3; average cost, $2.42.

Number of square yards laid in 1916 of two course, 16,875; base, 4 in.; mix, 1:1½:3; top, 2 in.; mix, 1:1½:3; average cost, $2.07.

The first concrete pavement was laid in 1895. Total number of square yards to date in which reinforcement was used, 16,875.

The prices quoted include the entire cost involved in laying the pavements, trimming the boulevard, adjustment of walk and all grading on the actual line of the pavement.

Toronto and Hamilton Highway

162,841 sq. yds. laid in 1915; 149,159 sq. yds. laid in 1916; general width of pavement, 18 ft.; spur line near Burlington of 7,323 sq. yds. is 9 ft. wide; in Oakville about 7,400 sq. yds. is 50 ft. and 30 ft. wide; one course pavement; mix, 1:1½:3; course aggregate of crushed stone from Dundas quarry; fine aggregate is a coarse sand; estimated cost, $1.40 per sq. yd.; the completed cost will be in the neighborhood of that figure. The surface is standing the wear very well. The repairs to cracks and joints on the 1915 work made in 1916 cost $76.71 for material and $200.34 for labor.

Walkerville, Sandwich, Ford City, Sandwich East and Canadian Steel Corporation

Total number of square yards of one course, 70,410; thickness, 6½ to 7 in.; at Sandwich E., 6 in. at side and 8 in. at centre; average cost, $1.25.

Number of square yards of two course, 223,992; base, 4½ in. to 5 in.; top, 2 in.; on 7,000 sq. yds., 1½ in.; average cost, $1.25.

Number of square yards of one course laid in 1916, 7,960; thickness, 7 in.; mix, 1:1½:3; reinforcement used in all excepting about 13,000 sq. yds. First concrete pavement laid in 1908.

Mr. Owen McKay, M. Can. Soc. C. E., of Walkerville, who was engineer for these pavements, after describing the earlier pavements laid, states he laid more than 4½ miles in 1914 in Sandwich E. under the Wayne County specifications. One course; mix, 1:1½ (clean washed gravel); 1½ miles, 16 ft. wide and 3 miles, 15 ft.; depth, 6 in. at side, 8 in. at centre; expansion steel joints 25 ft. apart. Only 500 lin. ft. today found with cracks, and so fine as to be scarcely noticeable. No reinforcement used.

In 1915 he laid two lines of pavement for the Canadian Steel Corporation, each 3½ miles long with a 25 ft. strip between reserved for street railway; mix, 1:2:4. No cracks have appeared excepting in a strip about three-quarters of a mile long where drainage was imperfect. Mr. McKay concludes that where width does not exceed 18 ft., with base flat, sides 6 in. and centre 8 in. and expansion joints not more than 30 ft. apart, wire reinforcement may be safely dispensed with, providing the sand and gravel are washed and free from impurities and all stones over 2½ in. in diameter, crushed and used in the above proportions.

Wingham

Total number of square yards of one course, 11,448; on main business street of town; length, 2,410 ft.; width, 40 ft.; thickness, 7 in.; crown, 6 in.; mix, 1:2:4;

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*City Engineer, Brantford, Ont.

reinforcement used throughout of No. 9 steel wire 6 in. x 12 in. mesh; expansion joints 40 ft. apart; Baker armor plates; cost, $1.35.

This pavement was laid in 1913, and no cracks have developed. Repairs have been made to a few high joints, holes and rough spots caused by frost. In all other respects the pavement has proved entirely satisfactory.

Woodstock

Total number of square yards of two course, 13,523; laid in 1916; base, 5 in., mix, 1:2½:4; top, 2 in., mix, 1:1½:2½; reinforced by No. 9, 4 in. x 10 in. wire fencing.

Windsor

To end of 1915, total number of square yards, 346,843. In 1915 number of square yards laid, 18,986; cost per square yard prior to 1915, $1.15; cost per square yard in 1915, $1.35. First concrete pavement laid in 1907.

The concrete pavements laid in the 33 places given in this schedule amounts to 1,366,660 square yards, of which over 75 per cent. is one course. The quantity reported as laid in 1916 is 350,048 square yards.

Ruthenian Catholic Church

at Montreal Partly Completed—Concrete, Steel, Brick and Stone—Designed in Byzantine Style

ONE section (the presbytery and basement) of St. Michael's Ruthenian Catholic Church, Iberville Street, Montreal, has just been completed, from plans by Mr. J. A. Karch, Montreal. It is proposed later to build the church proper, at a total cost of $75,000. In the meantime the basement will be used for worship.

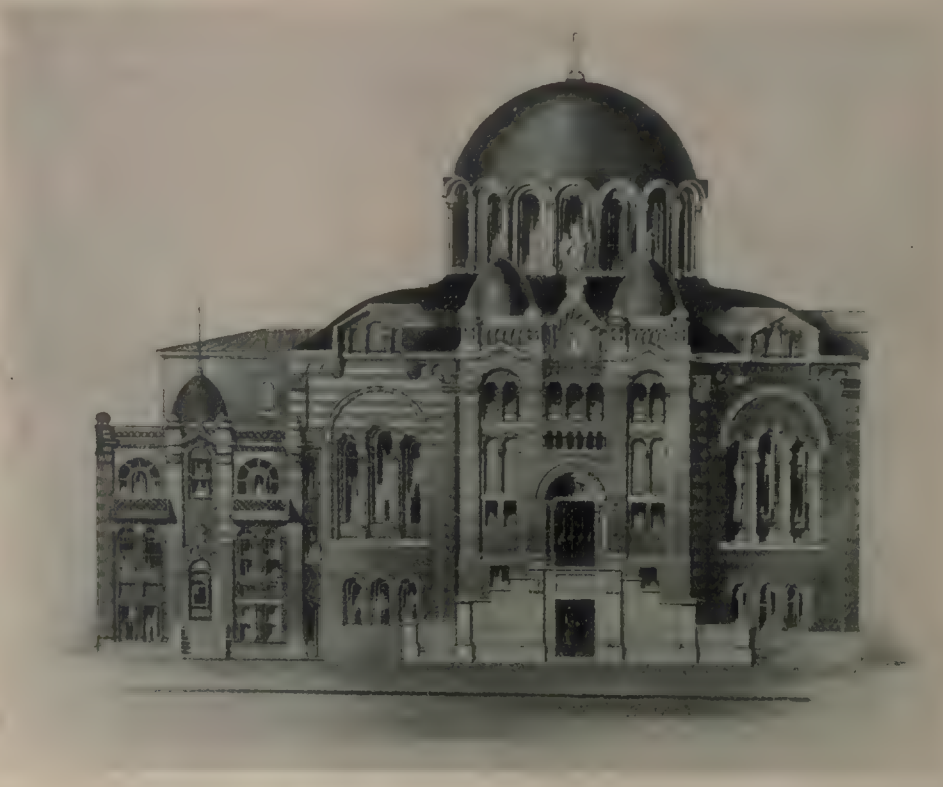
It will be seen from the cut that the church, to accommodate 2,000 people, is in the Byzantine style. The foundations are of concrete, while the superstructure will be of steel, with pressed brick of two shades, laid in alternate courses; brick is also used for decorative purposes. The window columns are of stone, and the same material is employed for trimmings. The presbytery has been constructed in accordance with these features, with the addition of iron balconies to the upper floor. The dome and roof of the church will be of copper.

There are to be two entrances, one to the basement and the other to the church, above the basement entrance, the church entrance being approached by concrete steps with iron treads. The plans show that it is contemplated to erect an inside stairway from the basement to the church, the stairway being continued so as to give access to the galleries, which will encircle three sides of the building.

The walls are backed with terra cotta and finished in plaster. The floors are of concrete, covered with hardwood. Four steel columns covered with terra cotta and plastered, support the roof. The windows are of steel sash, fitted with prism glass in the basement. The altar in the church will be placed at the south end. It is intended when the building is completed to use the basement as a meeting hall. At present there are, in addition to the space reserved for worship, various rooms for the use of the congregation.

The presbytery contains the usual domestic accommodation for the minister, and provision is made for

(Continued on page 466)



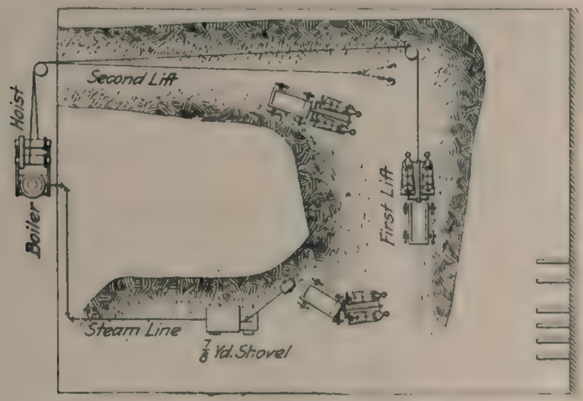
St. Michael's Ruthenian Church, Montreal, as it will appear when completed.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Snatching Wagons from Cellar Excavation

THE illustration shows the method of snatching wagons from a large cellar excavation in New York. This excavation was about 83x132 ft., and was performed by steam shovel for a depth of 16 ft. below street level, with hand work to trim it to a depth of 20 ft. The shovel was a ⅞-yard machine with steam supplied from the boiler of a hoist on the street level adjacent to the pit. Three-yard wagons were used for hauling the spoil away, these being loaded by the shovel. To snatch the wagons from the pit, the hoist referred to above was used, this having two drums from which two lines were run. The wagons were snatched in two lifts. The longer line from the hoist was attached to the hounds of a loaded wagon and pulled it rapidly to an intermediate elevation or landing, where this line was unfastened, the wagon given a half turn in the direction of the second incline and the second line fastened to the back axle. The load was thus drawn to the street level. By connecting the line to the rear axle and drawing the load backwards it was possible to place the two-sheave block shown well inside the curb line.



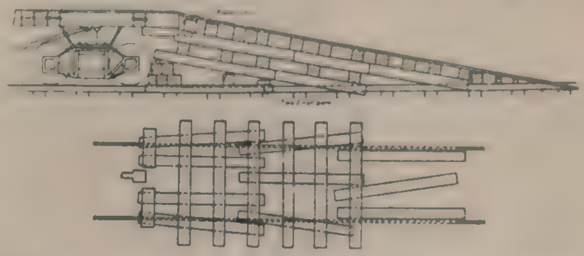
Steam hoist snatches wagons from excavation in two lifts.

Oil Burning Torches Break Boulders Where Blasting is Impracticable

LARGE nigger-head boulders up to 8 x 10 feet were encountered in subway excavation work in Brooklyn, N.Y. The nature of the work made it impracticable to break them up by dynamite blasting. Satisfactory results were obtained by the use of torches of the oil-burning variety which emit a very great heat. When one of these machines was concentrated on one point of the surface of the boulder for 10 or 15 minutes the great heat expanded the rock so much that it split at the seams. The operation was repeated on the smaller pieces until they were reduced to a satisfactory size for handling. The total cost for breaking up a large boulder of the size mentioned was about 60 cents, using two men and the torch, which consumed about 1 gallon of kerosene oil per hour.

Unloading Road Roller from Flat Cars

IN the absence of derricks or their equivalent, heavy machinery, blocks of stone, or other massive articles of moderate length can conveniently be unloaded from the end of a flat car by inclined skids. Long timbers are not always available, and different sizes of blocking or short chunks may not be at hand, besides which, if piled up carelessly they are likely to be unstable, and may be displaced or collapse under the load. A safe and convenient incline may almost always be readily built from standard 6 x 8 in. track ties 8 ft. long that are usually available. Some care has been taken to lay out an arrangement of ties for such a purpose, especially suitable for unloading heavy road rollers, and this has been published in a bulletin of the Illinois Highway Commission, from which the illustration is reproduced. This will enable any intelligent workmen to build a safe and efficient incline without difficulty. The load should be eased down the incline by a preventer rope or tackle snubbed on the car or to some secure anchorage in the rear.



Track ties make incline for unloading heavy machinery from flat cars.

White Paint Increases Light in Buildings

IT is significant that some of the larger new buildings for mercantile uses have had the walls of extensive offices they contain finished in a pure white. This has been due to a recognition of the fact that, in such buildings, white walls make for comfort, facility and efficiency in working, and that conditions which make for this have a cash value.

The effect produced on most minds by the painting of the walls of large offices as nearly pure white as can be attained is that a sense of increased light is produced. It is not a sense of a redundant, dazzling, or overpowering light, but of a light which is quite sufficient for easy and comfortable working.

It has long been recognized that the available light in large mercantile buildings, and in factories and workshops, has, to use the homely expression, only been half used. The power of the light has been diminished by the absorptive effect of dark or dirty walls and ceilings. Had these been kept reasonably white and clean the intensity of the light in the apartments would have been from one-third to one-half greater than it has been.

The greater cheerfulness and convenience of abundance of daylight in large office apartments is beyond doubt or question. The conditions of working are improved by it in every way, and the cost of gas or of electricity is much reduced.

Ruthenian Catholic Church

(Continued from page 464)

communication with the basement. The Spencer boilers for heating are placed in the basement of the presbytery.

The masonry work was done by Filion & Frere; brick work by Mr. S. Marotta; woodwork, Guertin & Bouchard; painting, Mr. C. Benard; plastering, Mr. J. Lefebvre; plumbing and heating, Tremblay & Francoeur. The steel was supplied by the Dominion Bridge Company, and the brick by the National Brick Company of Laprairie, Ltd.

A New Paving Mixer

A new paving mixer, built especially for road paving, but suitable for many different kinds of concrete work, is being marketed by Wettlaufer Bros., Limited. Among the outstanding features of this mixer are the following: Elevated drum, gravity being positive by reason of the high elevation; oval hopper, providing freedom from clogging, sticking and corrosion, all square corners being eliminated; two speeds, forward and reverse; extra strong water tank with facilities for measuring quantities for any size batch, and rear discharge, permitting speedy work on narrow roadways. The delivery chute is equipped with six gates, any one of which may be opened to deposit concrete on any part of the road. The chute swings in a complete half circle. Traction drive is connected to both rear wheels instead of one, insuring maximum driving power. This mixer is made in two sizes, 10 ft. and 15 ft. capacity, and is equipped with boom and bucket when specified, up to 18 feet in length.

New Books

Water Purification—by Joseph W. Ellms, Mem. A.S.C.E., etc. McGraw-Hill Book Company, publishers; price $5 net. The object of this book is to provide a fairly complete account of the development of the art of water purification. The various steps of purification processes, such as plain sedimentation, coagulation, filtration, and disinfection, are described in considerable detail. Several chapters are devoted to water softening and to the removal of iron and manganese from ground water supplies. A number of installations made at various points in the United States have been described, but, strangely enough, the author has omitted mention of the Toronto, Ont., rapid sand filtration system, decidedly one of the most modern and up-to-date on the continent, and representing a number of unique features which have added materially to the art of producing pure water. Illustrated throughout; 475 pages; 6 x 9 inches approximately; blue cloth binding.

Mainly Constructional

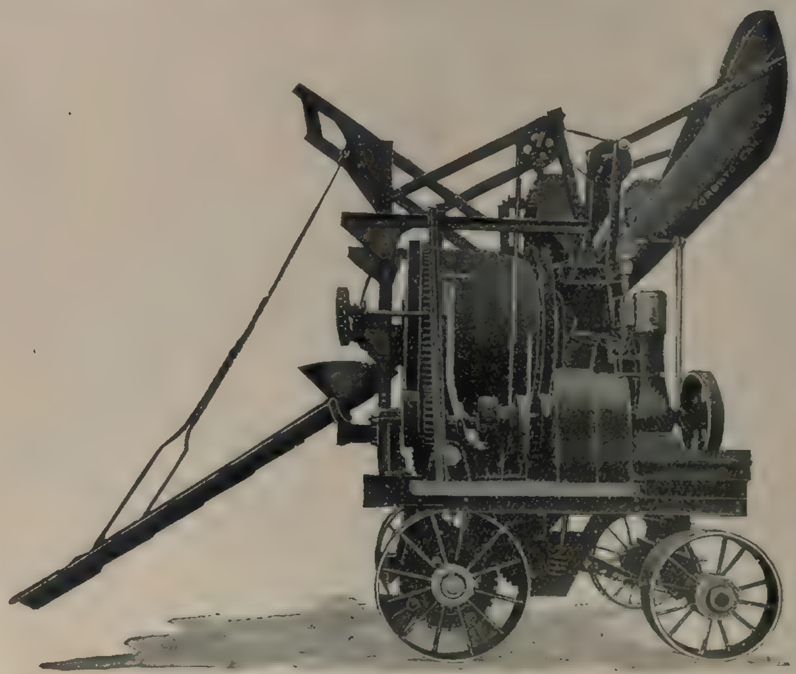
East and West—From Coast to Coast

St. John, N.B., is considering the advisability of codifying a new set of building by-laws.

A by-law has been carried at Hespeler, Ont., authorizing the issue of debentures to raise $14,000 to provide for extensions to the town's waterworks system.

The C.P.R. is getting work under way in connection with a concrete bridge which will be erected over the river at Minnedosa, Man., to take the place of the present wooden structure.

It is stated that work will probably start before the end



A new mixer built specially for road paving.

of this month on the erection of several hangars and other necessary structures at Ridley Park, North Toronto, which is being laid out as an aviation school.

At a recent meeting of the Council of Scarboro Township, Ont., it was decided to divide the township into eight sections, and a commissioner was appointed for each to oversee the carrying on of the road work.

The Ontario Railway and Municipal Board have decided that the last five miles of the Toronto-Hamilton highway be completed at a width of twenty-four feet, in view of traffic conditions, and that the extra cost be apportioned among the municipalities directly affected.

Following the demands made by civic employees, the Sewerage and Public Works Commission and the Water Commission of Guelph, Ont., have decided to grant them an increase in wages of 2½ cents, which brings the rate up to 30 cents per hour. This increase affects about 30 men.

A by-law will be submitted to the ratepayers of Peterboro, Ont., on May 31, endorsing the issue of debentures to the amount of $280,000 for the purpose of building bridges across the river at Hunter Street and at London and Hazlitt Streets. This is part of the agreement with the Quaker Oats Company.

Plans are being prepared for a sixteen-storey building to be erected in Amherstburg, Ont., by the Brunner-Mond Company, a subsidiary of the Solvay Process Company, of Detroit. It is said that the building will be one of the largest in the country devoted entirely to industrial purposes, and will cost in the neighborhood of $2,000,000.

The Toronto City Council have decided against the extension of Teraulay Street, repealing the by-law dealing with the proposal, and have abandoned the scheme for the widening of Kingston Road. They have also refused the proposals for new pavements on Silverbirch Avenue and Davenport Road, estimated at a total cost of $150,000.

Plans have been submitted by Mr. Emile Tanguay to the Catholic School Commission for the new St. Patrick's school to be erected on De Salaberry Street, Quebec. The building will be a three-storey and basement structure, and will provide accommodation for twelve classes, a dwelling for the brothers and a chapel. The cost will be about $137,000.

It is stated that two new factories will be established in Windsor, Ont., shortly. The Maxwell Motor Company have signified their intention of constructing a new plant on their site on McDougall Avenue. The building is to be of the reinforced concrete type of construction. Mr. Charles Mitchell also contemplates building an up-to-date brass and iron foundry.

On Friday, May 4, the Engineers' Club of Thorold, Ont., held an interesting meeting. Mr. Price Green, of the Canadian Northern Railway, displayed a series of lantern views, which were much appreciated. The views started at the eastern terminal of the railway and continued to the Middle and Farthest West, and portrayed some of the scenic marvels of the dominion.

A plan is under consideration by the North Fraser Harbor Commission for the creation of harbor facilities on the north arm of the Fraser River and making provision for the establishment of industries along its banks. It is the intention of the commission to request the government to proceed with the dredging of the channel from Iona Island to the easterly limits of Burnaby; the dredging of a channel 300 feet wide and 15 feet deep has already been done from Point Grey up to Iona Island. They will also ask the Dominion Government for permission to issue bonds to the amount of $1,500,000, with which to purchase about sixty industrial sites and to provide wharfage and trackage.

The C.P.R. has now suggested an amended plan to the city of Toronto in connection with the railway company's double-tracking scheme. The Railway Board has ordered a single steel bridge for the additional track across the ravine. The C.P.R. now agrees, however, to erect a concrete structure to carry the two tracks, and also to make provision now for the undertaking of the scheme of the Civic Guild for a vehicular bridge further north. The new plan will involve the closing of Summerhill and MacLennan Avenues and the construction of a subway at the east end of the concrete bridge. The railway company states that it will merely be necessary for the city to declare the policy and they will make the necessary grades and other provisions for carrying out the project.

Personal

The degree of civil engineer has been conferred upon Messrs. W. C. Smith, T. Taylor, and C. J. Townsend by the University of Toronto.

Mr. Alphonse Aubin, of St. Jerome, has been appointed to supervise the work on the waterworks and drainage scheme for Cap De La Madeleine, Que.

Lieut. Stewart H. Pepler, of Toronto, has been wounded in action. Prior to his enlistment Lieut. Pepler was engaged as an engineer with the Toronto Harbor Commission.

Gunner Thomas Vincent McCarthy, of Toronto, is reported wounded in action. He is a graduate of the School of Practical Science, and was formerly an engineer in the Works Department at Toronto.

Mr. F. P. Gutelius, M. Can. Soc. C. E., general manager of the Canadian Government Railways, has been offered the position of vice-president of the Delaware and Hudson River Railway. It is understood he will accept.

Lieutenant W. B. Pennock, Canadian Engineers, reported wounded, is a McGill graduate. After obtaining his degree in civil engineering in 1915 he received a commission at Ottawa. He has been at the front for over a year.

Lieutenant A. M. West, who, previous to his enlistment, was North Vancouver's municipal engineer, has recently been reported wounded. Mr. West left North Vancouver in charge of a draft from the Sixth Engineers about August, 1915. The municipality has been holding his position for him awaiting his return.

The honorary degree of LL.D. has been conferred by the St. Francois Xavier University, Antigonish, N.S., on Mr. D. H. McDougall, general manager of the Dominion Steel Corporation, Sydney, N.S.; Mr. M. J. Butler, C.M.G., past president of the Canadian Society of Civil Engineers, and manager of Armstrong-Whitworth Company of Canada; and Mr. Neil MacNeil, contractor, of Boston, who has been a benefactor to the university.

Major A. J. McPherson, of Regina, Sask., according to word recently received, has been appointed to the headquarters staff of the Fourth Divisional Canadian Engineers, with the forces in France. Major McPherson left Regina with a local battalion as second in command and on his promotion to the Engineers' headquarters retains his rank as major. He has had many years' experience in engineering work, and was at one time in the employ of the federal government, for which he carried out surveying work and territorial public work in the Yukon. He was also city commissioner of Regina for some time and later attached to the Local Government Board.

Obituary

Private John J. Tracy, of Toronto, is reported killed in action. Private Tracy was 31 years old, and worked as a contractor previous to enlisting.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Amherstburg, Ont.
Tenders will be called shortly for construction of reinforced concrete pavements and curbs on Apsley and Sandwich Street for the Town Council. Engineer, Mr. Newman, Fleming Block, Windsor.

Brooke Township, Ont.
Tenders received by the clerk, W. J. Weed, Alvinston, until June 2 for repairing Benner, Duffy and Rillett drains for the Township Council.

Colchester South, Ont.
Plans in progress for drainage work for the Township Council. Clerk, J. H. Madill.

Granby, Que.
Municipal Council plan waterworks improvements. Engineers, W. S. & R. S. Lea, 10 Cathcart St., Montreal.

Halifax, N.S.
Engineer's Department, City Council, plan $4,000 sewer extension. Engineer, H. W. Johnston.

Herbert, Sask.
Tenders will be called about May 28 for street grading, to cost about $3,200, for the Town Council. Engineers, Murphy & Underwood, 520 Fifth Ave., Saskatoon.

Leamington, Ont.
Town Council plan water storage tanks. Clerk, R. M. Selkirk.

Magog, Ont.
By-law for construction of sewers, sidewalks, and paving, costing $65,000, has been approved. Clerk, Alf. Touriguy.

Oshawa, Ont.
Plans being prepared for water filtration system costing $30,000 for the Town Council. Engineer, W. G. Worden.

Portneuf, Que.
Town Council plan construction of two miles of macadam roads. Tenders will be called soon. Engineer, J. A. Babin.

Ste. Foy, Que.
The Road Commission of Quebec, Parliament Building, Quebec, plan construction of four miles of macadam roads, costing $14,000. Engineer, W. Garvreau, Parliament Buildings, Quebec.

Saskatoon, Sask.
City Council plan sewer extension, costing $5,500. Clerk, Andrew Leslie.

Strathroy, Ont.
Town Council plan road improvements, plan to purchase two cars of gravel, and want prices on crushed stone. Clerk, F. W. Atkinson.

Sudbury, Ont.
Tenders received addressed to the clerk, W. J. Ross, until 1 p.m., May 28, for supply of all material and erection of a 500,000 gallon steel stand pipe for the Municipal Council. Plans and specifications at office of the superintendent, R. H. Martindale.

Westmount, Que.
City Council plan construction of macadam roads. City Engineer, P. E. Jarman.

CONTRACTS AWARDED

Portneuf, Que.
Quebec Concrete and Construction Company, 14 St. Roch St., Quebec, have the general contract for concrete sidewalks, costing $4,000, for the Town Council.

South Norwich Township, Ont.
A. Cooper, Otterville, has general contract for the construction of the "Singer" tile drain for the Town Council. Engineer F. J. Ure, Woodstock.

Walkerville, Ont.
Merlo, Merlo, & Ray, 296 Windermere Road, have general contract for construction of 2,500 square feet of concrete pavement, costing about $4,800, for the city.

Merlo, Merlo & Ray, 296 Windermere Road, have general contract for construction of 9,694 square feet of concrete sidewalk for the city.

West Zorra Township, Ont.
Deviney & Campbell, Embro, have contract for supplying tile and Alex. Tree, Embro, has contract for construction of tile drain for the Township Council. Engineer, Allan Murray, Embro.

Winnipeg, Man.
E. T. Hungerford Brass and Copper Company, New York, N.Y., have the general contract to supply the Greater Winnipeg Water District with bronze castings.

York Township, Ont.
The Dominion Construction Company, 14 Wellington E., Toronto, have contract for construction of mains on Eglinton Ave., Baby Point, Jane, etc., at a cost of $43,011, and Mitchell & Mohan, 303 King St., London, have contract for mains on Oakwood and Weston Road, costing $21,122.

Railroads, Bridges and Wharves

Biddulph Township, Ont.
Tenders will be called early in June for the erection of two concrete bridges for the Township Council. Engineer, Chas. Talbot, County Buildings, London.

Brome, Que.
Township Council contemplate the erection of a steel bridge. Secretary-treasurer, G. F. Hall.

Lobo Township, Ont.
Tenders will be called early in June for erection of two concrete bridges for the Township Council. Engineer, Chas. Talbot, County Buildings, London.

Public Buildings, Churches and Schools

Carmangay, Alta.
Town Council plan municipal hospital. Address, Mayor or Hon. Mr. Gariepy, Parliament Buildings, Edmonton.

Chateau-Richer, Que.
Plans and specifications with the chairman of Building Committee, L. Tremblay, and the secretary-treasurer, C. Metot, who will receive tenders until June 1 for erection of $5,000 brick school for the School Board.

Halifax, N.S.
The School Board, 81 Sackville Street, plan addition to St. Joseph's School. Secretary-treasurer, Miss S. J. Wilson.

Hamilton, Ont.
The Russian Church plan erection of a $30,000 brick church.

The Servian Church plan erection of a frame and brick church.

Indian Reserve, Ravenswood, Ont.
Plans and specifications with the chairman of Building Commision, P. McKellar, Forest, who will receive tenders until May 28 for erection of $4,000 school and residence for Department of Public Works, Dominion Government.

Kentville, N.S.
Tenders received by the Commissioner of Works, Hon. E. H. Armstrong, Halifax, until May 26, for installation of steam piping and equipment for sanitorium for the Provincial Government. Separate tenders for trenching.

Kitchener, Ont.
Tenders close May 28 for erection of $90,000 hospital for the Sisters of Charity, Kingston. Plans and specifications at the office of the architect, A. W. Holmes, 10 Bloor St. E., Toronto, and with Rev. A. J. Fischer, St. Mary's Rectory.

London, Ont.
The Western University plan erection of a university building. President, E. E. Braithwaite.

Megantic, Que.
Tenders open for erection of frame school for St. Agnes de Ditchfield School Board. Secretary-treasurer, D. L. Lippe.

Monteith, Ont.
Tenders close May 30 for erection of residence for training school at experimental farm for the Department of Public Works, Provincial Government. Plans and specifications at Agricultural Department Agency, New Liskeard, and with the Provincial Architect.

Montreal, Que.
The Roman Catholic School Commissioners, 87 St. Catherin W., plan school, costing approximately $84,000. Chairman of Building Commission, Canon W. O'Meara.

Ottawa, Ont.
Tenders received by the Board of Control until May 29 for erection of exhibi-

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Alphabetical Index of Advertisers
Page 16

Vol. 31 **May 30, 1917** **No. 22**

Principal Contents

	Page
Editorial	469
Methods of Cutting Down Labor Costs	471
Proposed Tunnel is Longest in the World	472
Many Bridge and Culvert Problems	474
Electricity for Sewage Purification	476
Percentage System in Building Work	476
Painting Exterior Concrete Surfaces	478
Bituminous Materials in Road Work	479
Practical Hints for the Contractor	482
New Design for Screen Chamber	483
Board of Engineers Make Report on Montreal Aqueduct Situation	485
Mainly Constructional	488

The Effect of High Prices

UNCERTAINTY in the building and allied industries seems to be growing apace. No doubt the very rapid changes in the prices of materials has not a little to do with this. No limit to the soaring seems to be in sight and the already sky-high prices are quite possibly due to go higher before a turning point can be expected. This uncertainty as to what turn events will take has had a very marked effect on engineering and building problems. They have been considerably complicated and confused and their recognized standards, applicable in normal times, fail under existing abnormal price inflation.

The rise in prices has exerted a deterring influence on certain classes of engineering and contracting work. On others it has been the cause of a revision of plans or expenditure. For example, the phenomenal high cost of steel at this time, coupled with the difficulty of securing delivery promptly or in quantity is stimulating the use of concrete if this material is at all applicable to the work in hand. One instance which bears this out is a railway company planning improvements in Toronto and authorized to go on with the plan to build a large steel bridge as part of the improvement. Since the authorization the company has outlined an amended plan, providing for a reinforced-concrete bridge instead of the steel. Just what motives actuated the presentation of the revised plan are uncertain, but, if we are to judge by other similar cases, the use of concrete probably entailed a smaller expenditure, and gave assurance of more prompt completion. However, this position of concrete seems doomed to be uprooted. Although its price has held pretty firm for some time past, the recent increases, to be greatly augmented in the future, it is prophesied, will cut the margin that concrete now possesses over steel.

* * *

This circumstance will serve, perhaps, to bring timber to the front. In fact, there is evidence that timber is already being received with more favor. This material has fluctuated to a less extent comparatively, a fact that has influenced designers and builders to make more extensive use of it. Throughout the country, factories or warehouses of timber mill construction are more in evidence. The abundant use of wood in house construction has tended to keep the cost of this type of building down against the rising costs of masonry and fittings. Partly for this reason residence construction is reported fairly active.

The effect of these unusual conditions is to stimulate the use of low-priced materials. This is done even at the sacrifice of long life. It is figured that cheaper materials even though subject to more frequent replacement are more economical under present conditions than the better quality goods.

The effect of high costs can be counterbalanced by another alternative, however, than by replacing standard materials with cheaper ones. This is by taking measures to conserve labor and material, by eliminating extravagance and waste and by employing suitable mechanical measures to replace hand labor. The labor scarcity—and it is this factor that, in the end, is making costs high—has imposed upon contractors and manufacturers of materials the necessity of using machinery to keep costs within bounds. On many jobs the value of mechanical devices is now realized to the advantage of both owner and builder. Outside of all this, however, a thrift campaign could well be inaugurated in connection with building work. One needs to take but a glance at the average job to see waste rampant. By taking measures to eliminate this and by putting operations on a plane of higher efficiency, costs can be kept from mounting unduly.

* * *

The whole question of rising prices is one that has to be carefully considered. The first tendency is to get frightened and to stop all operations. But building need not be allowed to come to a standstill. The prevailing prices to-day are a result of more or less abnormal conditions. Markets are chaotic and the labor situation disjointed, while government demands are leaving only a small portion of most manufactures for private consumption. Under these conditions, prices may well be uncertain—whether justified to the present extent is another question. At least the matter calls for measures on the part of engineers and contractors, to make the most out of a difficult situation.

The Possibilities of Water

We are all apt to think of water as being restricted in its applications, but there are many profitable uses for it, if only a little publicity were given. The following comment, in Engineering and Contracting, gives expression to the wider possibilities in the uses of water, and urges an educative compaign to have these recognized:

Engineers and waterworks managers in America have come to entertain an almost reverential respect for a city that is able to hold its water consumption below 100 gallons per capita. This old "100 gal. per capita" is in danger of becoming an ideal, analagous to "100 per cent. efficiency," yet with no real reason back of it further than that it is possible to serve the average American city with no more than "100 gallons per capita" and satisfy everyone.

In England, however, the corresponding deal is about "50 gallons per capita." Does that prove the English to be twice as efficient as the American waterworks manager? If not, what does it prove? Simply this, that where the average income of citizens is small their necessities force them to conserve it, and contrariwise when the income is large. That Americans waste a vast amount of water because it is not metered is known to all hydraulic engineers, but it does not follow that our ideal should be the ultimate reduction in water consumption per capita. Rather our ideal should be a reduction in the per capita waste and an increase in the per capita use of water in economic ways and to increase the health and pleasure of our people. It is quite conceivable that such a use may lead eventually to an average water consumption of 250 gallons per capita or more. We Americans use four times as much electricity per capita as do the English or French. Yet who charges us with undue wastefulness in the consumption of electricity? No one, for electricity is almost universally sold as a metered "commodity," making it distinctly and evidently unprofitable to the individual who wastes it.

Water and Electricity Contrasted

"But," it will be urged, "electricity has many possible uses, whereas water has but few. Electricity, therefore, can be marketed intensively and extensively. Water cannot." Is this last conclusion justified, even if it is conceded that electricity has more fields of usefulness than water? We doubt it.

The sale of any product is not altogether dependent upon the number of uses to which it may be put, but it is dependent upon the understanding that the public has of its relative worth—upon the educational advertising that it has received. Cameras have relatively few uses, but the sales of cameras have become enormous through publicity. The same holds of innumerable things. Of all "public utilities" water has gained the least in "popularity" and sale, largely because it has not been given proper publicity.

The uses of city water? Are they so few after all? Not to mention the everyday uses for bathing, washing, cooking, and drinking, there are innumerable commercial uses. Possibly none of these uses can be greatly increased through educational publicity, although we doubt that. If water were sold by meter, would it not pay to induce owners and architects to install shower baths in every bathroom, and to encourage the use of the shower by every person, morning and night? Surely there would be no greater difficulty in accomplishing such an education than there has been in showing the public that "electric toasters," "irons," "vacuum cleaners," and "washing machines" are necessary domestic instruments.

Waterworks Men Indifferent

But here we waterworks men sit, dead to the evidence of the success of educational publicity on every side of us, excusing our inactivity on the ground that "our business is radically different from others." What of our opportunity to sell water for backyard and vacant lot irrigation? What of the "respiratory organ disease" that we might prevent by the extensive daily flushing of our streets? Is Seattle, with its astonishingly low mortality (8 per 1,000), no object lesson in the effectiveness of street flushing from city hydrants and from frequent rains? What of snow removal by scraping into sewer manholes and washing away with floods of water? What of the possible remodeling of our sewer systems to facilitate the more extensive use of water for carrying away dirt, refuse, and even ashes? Who that has seen the hydraulic miner and the hydraulic dredger at work can doubt the efficiency of water as a carrier of materials heavier than water?

Why, the possible uses of water are almost numberless, yet the actual use to which water is now put in our cities is so limited as to make us exclaim in wonder at the general ignorance. Who is to blame for this ignorance? We engineers, we waterworks managers, and we publishers of technical periodicals and books—all are in the same half-scuttled skiff, drifting without paddling, even though we have the paddles and know how to use them.

We must entirely change our attitude of complaisance and inaction. There are countless uses to which city water may be profitably put. Let us search them out and show the public what they are.

Montreal Builders' Exchange Have Smoker

To celebrate the opening of their new offices in the Drummond Building, the Montreal Builders' Exchange held a smoking concert, presided over by Mr. W. Ramsay, of the Pedlar People Limited. Mr. James Simpson, the first president of the exchange, and Mr. R. A. Bremner, who were among those who obtained the original charter, were present. The former gave an outline of the history of the exchange. Messrs. J. P. Anglin, the president, N. Beullac, J. E. Walsh, W. C. Munn, Alexander W. Bremner, and John Quinlan also spoke.

Road Work Incurs Damages

In the Superior Court, Montreal, Judge Panneton has ruled that it is when the provincial government is liable for damages through road construction work executed under the Quebec Good Roads Act that the special provision of the law regarding the appointment of arbitrators for the assessment of the damages may be applied. In the event of damages being alleged against a municipality as the outcome of road building, then an action will lie for compensation in the Superior Court. He gave judgment for $100 against the Municipality of St. Basile de Grand in an action brought to recover damages for alleged injury to property through the installation of stone crusher, engine, etc., used in road construction work.

Methods of Cutting Down Labor Costs

Two Typical Jobs Illustrate Extended Use of Mechanical Equipment to Eliminate Large Labor Forces and Reduce Labor Costs

By W. P. Anderson[*]

THE difficulties encountered in the labor market this last year have forced contractors as well as employers in other lines of work, to make use of as many labor-saving devices as possible. By so doing many contractors have succeeded not only in eliminating a large number of their former labor forces, but in cutting down the labor costs as well.

A brief description of two typical jobs will illustrate this extended use of mechanical equipment. The contract for a large high school building, calling for the erection of a group of five buildings three storeys high, is one of those that has been handled with comparatively low labor costs in spite of market conditions. A temporary spur track was laid from the railroad to the site of the five buildings, tower and bridge which comprise this reinforced concrete job. The concrete mixing plant was placed beside this spur track. It consisted of a suitable mixer placed at the base of a tower 210 feet high, from which a steel cable ran to a shorter tower 80 feet high in the line of one of the wings of the buildings 800 or 900 feet away. Sand and gravel were unloaded from cars by a clam shell bucket and dumped into storage bins above the mixer. A storage pile of aggregate was left on the ground to prevent delay in case the cars did not come fast enough to keep the bins filled. The derrick was raised up enough from the ground to enable the operator to look into the cars and determine exactly what his bucket was doing. From the bins the sand and stone was dumped directly into a Koppel car so divided that the proper amount of sand and stone for one mix could be readily measured. This car was then run along and dumped directly into the mixer.

A concrete distribution system like this keeps labor costs down. The main chute is suspended from a cable between two towers, the other from a split boom. Vertical drops are used in the main chute.

The mixed concrete was hoisted up the main tower and dumped into either one of the two hoppers on the side of the tower. One of these hoppers feeds the main line chute which hangs from the steel cable. The other feeds the shorter chute line suspended from a split boom. Vertical drops were used in the main chute line.

Chutes in this case are carried on tripods fitted with large wheels to permit rapid adjustment of position.

Economy in Handling All Materials

In addition to the labor saving devices on the concrete plant there was a gravity conveyor system for handling reinforcing steel, tiles and other miscellaneous material. Cement was unloaded directly from the cars into a cement shed, using gravity conveyors. The capacity of this shed was 1,300 barrels, and with this arrangement only six men were required to unload a car of 240 barrels in about 2¼ hours. Another feature of this job which was instrumental in keeping down labor costs was the care exercised in laying out the plant. Besides this, the special mat system of floor forms used enabled three carpenters and two laborers to lay about 6,500 square feet of floor forms per day.

Another job which exemplifies the use of economical methods is that of a large mill and warehouse for a milling concern. On this job the sand and gravel came in self dumping cars and was dumped directly from the car into the sump hole beneath the track. From here it was hoisted by endless chain buckets into bins near the mixer, the chain hoist being so arranged at the top that the sand could be dumped into one of the two bins and the rock into the other. Of course, it was necessary to dump only one kind of material, either sand or gravel, into the underground sump at one time. From the bins the material went by gravity directly to a measuring hopper and the mixer. The capacity of the concrete outfit was 25 cubic yards an hour.

From the mixer the concrete was hoisted up the tower and dumped into a receiving hopper from which it flowed through a chute line to the forms. Wheelers were eliminated. The first chute was suspended from the receiving hopper and a split boom. Beyond this point the supports consisted of special tripods fitted with large wheels which could be moved over the reinforcing steel and practically anywhere desired. This enabled the chute line to be moved from point to point quickly with comparatively few laborers. At times a smaller bicycle frame was used to carry the end of the chuting line. This does not show in the accompanying illustration, but is simply a frame supported on two large wheels which roll over reinforcing steel with comparative ease.

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[*] President, The Ferro Concrete Construction Company.

Efficient Methods Counterbalance High Costs

In spite of the fact that the price of labor has gone up from 40 to 50 per cent. in the last two years, the contractors have succeeded, by using such methods as outlined here, in bringing its cost of handling concrete down appreciably. On the last job described labor cost was 1.482c for the mill and 1.391c for the warehouse. These two buildings were handled with practically the same concrete plant. The yardage for the mill was 2,267 cubic yards, for the warehouse, 907 cubic yards. The cost thus far on the school first mentioned, which is only partially completed, but which is based upon the yardage for the entire building and will be approximately correct, is 1.299c per cubic yard. The actual number of cubic yards already placed is 4,661. The number to be placed is about 7,700. The hourly wage for the laborers on the job was from 25 to 30 cents, the majority being paid 25 cents. A strike among the laborers on this job resulted in a little of the concreting being done by carpenters at a slightly increased cost. On the school job the laborers received from 27.8 to 30 cents per hour. The average was about 28.5 cents.

Proposed Tunnel is Longest in the World

A Railway Tunnel, 30 Miles Long, Through the Cascade Mountains—Estimated Cost and Progress in the light of the Connaught Tunnel Experience

OUR article in the last issue of the Contract Record describing in detail the work on the Connaught or Rogers Pass Tunnel, one of the world's most wonderful achievements, adds special interest to a proposal made by General H. M. Chittenden, of Seattle, Wash., U.S.A., to build a tunnel through the Cascade Mountains in the State of Washington, which, if consummated, would be the longest railway tunnel in the world. The tunnel as projected by Gen. Chittenden, having a length of thirty miles, would be important not only on account of the magnitude, but because of the economic advantages it would possess. The length is about two and a half times that of the Simplon Tunnel, the longest railway tunnel yet driven.

Present Conditions Very Difficult

A number of reason have given rise to the proposal. In the first place, Puget Sound, on the Pacific Coast, has immense trade possibilities, but on its eastward side it is hemmed in by the high mountain walls of the Cascades. The lowest passes across this barrier are more than 3,000 feet high, and they become practically impassible in the more severe storms of the winter. In the past ten years there have been three winters in which rail traffic across the Cascade Mountains in Washington has been completely stopped for periods of from one to three weeks. There have been several other winters in which the interruptions, though less complete, have been serious. There have been only two or three winters in which approximately normal traffic conditions have been maintained throughout. During the past decade there have been some grave accidents, with heavy loss of life, and there has been a prodigious financial loss to the railroads and the community.

Further, in crossing these mountains the grades are
ing,avy and the summit is high, traffic having to be
mercial [illegible] an elevation of around 3,000 feet in crossing
ly increase by the present railway lines. So long as the
we doubt tha crossings are maintained it will never be
not pay to eliminate the waste of energy involved in
the half-mile vertical lift over the range, nor the delays, dangers, and enormous maintenance cost due to heavy gradients, excessive curvature, and to winter conditions.

The problem that was presented, then, was: Can a route be found on which a tunnel may be built under the Cascades, at an elevation low enough to eliminate the worst grades and practically all the winter difficulties of the present crossings?

The railways occupy the best passes, and in the construction of their lines have employed tunnels in only three cases, the longest of these being 13,500 feet and their elevations 2,560 feet, 2,837 feet, and 3,375 feet. The gradients on the approaches vary from 1 per cent. to 2.2 per cent. over distances of 10 to 30 miles.

Longer Tunnel Only Means of Relief

These figures show that the tunnels do nothing more than pierce the thin comb of the ridge, leaving the approaches for long distances supported on precipitous mountain slopes with excessive gradients and subject to the dangers inseparable from such situations. No substantial relief is possible except by building much longer tunnels. The trouble is that the railways individually—of which there are five in this district—could not go to this expense unless driven to it by dire necessity. Mr. Chittenden suggested a combination by which the roads might jointly build a low-grade route so located as to be conveniently available to the several lines, in this way preventing an undue burden of expense on any single company. After investigation, one route appeared feasible, the location being such as to benefit the railways mutually. On this route it was possible to reduce the gradients to 0.6 per cent. up to two points separated by a distance of about thirty miles. This obstacle was, according to the plan, to be overcome by a tunnel.

To this relocation there are a number of advantages, of local economic interest, which may reasonably be passed over. The feasibility of this project and the methods to be followed are matters that are of more practical value.

It may be stated at once that the technical problem presents nothing which should seriously challenge the resources of the engineering profession. The only feature that would establish a precedent would be the length, which would be nearly three times as great as that of any railway tunnel yet built.

The nearest approach is in the Alps, where there are five tunnels—Mont Cenis, 8miles; Saint Gothard, 9.3 miles; Arlberg, 6.5 miles; Simplon, 12.3 miles; and Loetschberg, 9 miles—the aggregate length of the three longer being just the same as that of the proposed Cascades tunnel. There are many railway tunnels in various parts of the world, ranging from two to seven miles in length. The Catskill Aqueduct for the New York water supply is 120 miles in length, of which 49 miles was driven in tunnel.

Serious Difficulties Not Anticipated

Some of the Alpine tunnels developed obstacles much more serious than any which it is believed will be encountered here. The Cascades rock is mainly granite, with some schist at the western end and possibly a short stretch of sandstone about midway. It is not likely that serious difficulty will be encountered from excessive heat, the sole surface indication being a warm spring on the Great Northern, three miles north of the line and at elevation 2,200, with a temperature of 130 degrees F. No trouble from this cause was experienced in any of the three tunnels already built through the Cascades. The Cascade granites carry more or less water, but not in troublesome quantities, judging from experience on the Great Northern tunnel.

The cost of the work as affected by interest charges during construction is so dependent upon the rate of progress that both matters will be considered together in this division of the subject.

In the matter of progress in tunnel building there has been continuous improvement since the first long Alpine tunnel was built. This is well shown in the following table:

Alpine Tunnels

Name of tunnel.	Date.	Length. Miles.	Rate of progress. Feet per day.
Mont Cenis	1857-71	7.5	7.75
St. Gothard	1872-81	9.5	18.00
Arlberg	1880-84	6.5	27.25
Simplon	1893-99	12.25	36.00
Loetschberg	1906-11	9.00	36.00

In the Rogers Pass Tunnel progress was made at a rate of 3.6 miles per year, or about 52 feet per day.

Upon the whole, the Rogers Pass experience seems most applicable to this project. The extraordinary record made was due to a favorable rock and to the use of the comparatively new method of driving a small auxiliary tunnel in advance of and at one side of the main bore, from which cross-galleries were run and additional headings opened up. Undoubtedly the same expedient would be applied to the much larger work here considered.

In the estimates which follow, and which have been prepared and published by Mr. Chittenden, the followings dimensions for the cross-section of the tunnel have been assumed: Width, 30 ft.; height at centre, 25.5 ft.; height over outer rail, 22.5 ft.; net cross-sectional area (after lining) about 650 sq. ft.; gross area in excavation, about 850 sq. ft.

The great length of the tunnel naturally suggests resort to intermediate shafts in order to facilitate progress. The question of their use turns mainly upon their effect in shortening time of completion and thereby saving interest and hastening the period when the work may become revenue-producing. These shafts would be expensive, about $100 per foot depth for a deep shaft of, say, four compartments (about 250 square feet cross-section), and would take considerable time to construct, 100 feet per month being standard experience. There are four possible locations for these shafts, known as Deception Creek, Upper, Middle, and Lower Icicle Creeks. In analyzing their probable value in expediting the work and reducing interest charges, a somewhat higher rate of cost than previously indicated has been assumed—namely, for the Lower Icicle Creek shaft (1,100 feet deep), $150,000; for the Middle Icicle and Deception Creek shafts (1,700 and 1,860 feet respectively), $250,000; and the Upper Icicle shaft (2,320 feet), $350,000. The estimated effect of these shafts in reducing time and cost is shown in table.

The pioneer tunnel and the several shafts would be of great value in the subsequent operation of the tunnel. While ventilation with electric-train operation is not a difficult problem, still it would be materially simplified by the auxiliary tunnel and the shafts. High speed operation of trains would be essential, and the air pressures would be lessened by frequent connections with the side tunnel, while the shafts would have a similar effect and would promote frequent complete changes of air.

Rogers Pass Work Forms Basis for Estimates

At Rogers Pass, as already stated, a rate of progress of 3.6 miles a year was attained, or a mean of 1.8 miles from each end. In the estimates from which Table 2 is made up it is assumed that 1.6 miles per year could be maintained from each portal and 1.4 miles each way from each shaft. It is assumed that the widening for necessary sidetracks would be equivalent to 1.2 miles of full tunnel section, thus making an equivalent total length of 32 miles. If shafts were used, the time would be controlled by the longest subdivision and by the rates of progress at its two ends. Thus, with no shaft, the length would be 32 miles and the annual rate 3.2 miles; with one shaft, the controlling section would be 17.4 miles and the rate 3 miles; with two shafts, these figures would be 14.4 and 3 respectively; with three shafts, 11.2 and 2.8; and with four shafts, 7.5 and 3. It is assumed that two full years would be consumed in installation of plant, including shafts, and in getting well started; 12 months in getting the tunnel into operation after the main bore is holed through. The times of completion under these assumptions are shown in table.

In arriving at an estimate of cost reliance is based largely on the Rogers Pass experience, but other work and authorities have been consulted as well. The following unit prices are, it is believed, conservative, if the tunnel is driven from the ends only:

	Per lin. ft.
Plant (except shafts)	$ 5
Excavation of bore	120
Lining tunnel	75
Tracks and equipment	5
Surveys and miscellaneous	5
Total	$210

It is assumed that the item for excavation from the shaft headings will be $5 greater than given in the preceding tabulation, this increase to cover the extra cost of removing muck and water through the shafts.

With the foregoing assumptions, with an interest rate of 6 per cent., and an interest period equal to half the period of construction, the details as to costs and times are shown in the table. The second column includes the increased plant cost of shaft installation, as already given, and the extra cost of $5 per foot for removing muck and water by the shafts.

Time Required for Completion and Cost of Cascades Tunnel

Scheme.	Cost.	Time,yr.	Interest.	Total.
No shafts ..	$35,481,000	13.0	$13,837,000	$49,318,000
One shaft ..	36,127,000	9.0	9,754,000	45,881,000
Two shafts .	36,429,000	8.0	8,743,000	45,172,000
Three shafts.	36,659,000	7.0	7,698,000	44,357,000
Four shafts .	37,114,000	5.5	6,123,000	43,237,000

A. C. Dennis, superintendent for the contractors on the Rogers Pass Tunnel, to whom these estimates were referred by Mr. Chittenden, expresses some doubt as to the practicability of securing this efficiency from the shafts. He is inclined to favor doing the whole work from the portals only, or at least using only the one shaft nearest midway of the tunnel. In this connection he made the following observation in a letter:

"Under normal rock and water conditions this tunnel can be finished ready for operation, working from the portals only, in nine years. With a bonus, or forfeit claim based on nine years' time limit, I am satisfied that this work can bet let for $33,000,000, to cover every expense in connection with the work until ready for operation and with an additional reduction of $70 per foot for an unconcreted section."

Considerable Open-country Work Necessary

The costs as given in the table pertain to the tunnel only. To make this work properly available by giving unrestricted access to all railway lines, the system should be extended on both sides to the natural points of divergence. This would add probably 50 miles of open-country double track, which are estimated at $4,000,000.

It may be objected that this route would be practically available to only one of the railroads entering the Puget Sound country—namely, the Great Northern, which lies directly on the route of the tunnel. The answer is that, long before such a work could be carried to completion, the development of the Columbia Valley will have brought the other lines as far north as Wenatchee for local traffic only.

Many Bridge and Culvert Problems

Expenditures in Many Cases Avoidable—Future Requirements Often Not Considered—Strong Foundations a Good Investment

By Lucius E. Allen, C. E.*

THERE are a few points in connection with highway bridges which are many times lost sight of by municipalities. In considering the economical side of highway bridge construction there are two classes of expenditures, namely, those expenditures that may be termed avoidable and those that cannot be prevented. The greatest financial and economical losses on the part of many municipalities fall under the first class, and could, with proper foresight, be saved. There are countless instances of bridges which have been built even within the past ten years that were either so poorly designed or improperly constructed as to require extraordinary and expensive repairs, or in some cases replacement with new bridge structures. At the present time, with the best of materials, steel or concrete, there should be no apology required from any municipal body for not constructing their bridges in the best manner possible.

Future Requirements Should Be Met

Owing to the use of increasingly heavy motor trucks modern bridges should be designed for future requirements, so as to safely carry any load that may pass over them. There exist many highway bridges which could not be considered safe under a five-ton load, and many more that would not safely sustain a ten or fifteen-ton load. It is also difficult in many cases in the construction of a bridge to predetermine what may be required of it in the future. A diversion of traffic may suddenly or gradually take place on a given road which will increase not only the density but also the loads passing over any particular bridge; and, for this reason, it would seem to be the better economy to overestimate the future requirements of every new bridge to be built. In addition to heavy motor trucks, the traction engine and road roller is another important factor to be considered in designing the bridge. In view of the increased construction of good roads througout the country, heavy machinery for their construction are required to move over nearly all roads passing through the more settled portions of our country, and as the bridges must be considered as a component part of any improved highway system, it is very essential to take into account the future requirements.

I know of a municipality having a large number of bridges, many of them old wooden structures, that for years they had neglected to rebuild, and only after one or more lives were sacrificed through bridge failures was action taken to reconstruct the bridge system with safe and modern structures. Such bridge losses as are here referred to can surely be classed as avoidable expenditures, providing the required amount of money had been wisely spent in the first instance.

Further Avoidable Expenditures

Another quite common fault that causes in many cases large "avoidable expenditures" of public money is the selection of a poor foundation. One case which illustrates this point, and which came under my notice within the past two years, was of a bridge which had been placed on concrete piers which had a very poor foundation—so much so that one pier commenced to tip so badly as to endanger the steel superstructure. It was necessary to remove the pier entirely and construct a new pier upon a sound foundation, which was done by means of a steel sheet pile cofferdam. This work cost several thousand dollars, and could have originally been done properly for very much less money. Another case in point is of a bridge whose masonry piers were built on wooden plank platforms resting on wooden piles. Owing to movement of piling the planking became displaced, which resulted in several of the piers tipping so badly as to require reconstruction, which work is now being carried out. Had the original construction been properly designed and executed the large cost of reconstruction would have been avoided. In considering the construction of one or more highway bridges no set type of design, either in foundations or superstructure will be found suitable or economical in every case. Each bridge should be considered by itself—a careful examination made of the locality, the foundation condition, drainage area, danger of washouts—before deciding on the particular design best adapted for the particular bridge.

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* Engineer, Hastings County, Ontario, before Canadian and International Good Roads Congress.

The matter of proper bridge approaches is in many cases neglected as not being an important part of the finished bridge. If the approach is at all elevated above the side ditches either strong wooden or iron guard rails should be provided.

Trees Prevent Underwashing

In some cases where the spring freshets are particularly severe, and there is danger of underwashing of the abutments, the planting of certain kinds of trees along the banks of the stream above the bridge is found to be beneficial. Willow trees are especially adapted for this purpose.

The lack of properly painting steel bridges is probably one of the most common causes of rapid deterioration of highway bridges. It is often difficult for municipal officials having charge of highway bridges to secure sufficient funds from the municipalities to properly paint steel bridges, no matter how often or how strongly the importance and economy of keeping the steelwork painted is impressed upon the municipality. In all cases the steel bridge should be painted not less than every three to four years, but in many instances they are not painted oftener than once every five to ten years. If allowed to become bare or exposed it is very difficult to prevent pitting, and once corrosion commences it is difficult to entirely prevent continued loss through exposure. Many steel bridges have become unsafe and entirely unsuited for traffic solely from lack of proper attention to the preserving of the steel by paint or other suitable preservative coatings.

Suitability of Reinforced Concrete Bridges

Where foundation conditions are suitable the reinforced type of bridge is undoubtedly the best type to select in point of permanency. It is not difficult, however, to point to reinforced concrete bridges that, through faulty design or poor construction, have proved failures. The type, however, should not be condemned on account of the failure of isolated cases that have been improperly constructed. There are today thousands of reinforced concrete bridges throughout the country that have sufficiently stood the test of time as to leave no doubt as to the permanency and adaptability of this type of bridge construction. Concrete also lends itself to far greater architectural effects in bridge design than steel, providing care is taken in finishing the exposed surfaces and carrying out the lines of the side walls along approved architectural methods.

The width of roadway is also of importance. While a width of sixteen feet is considered a standard width for ordinary country highway bridges, it is questionable if, on many of our more important highways, the width should not be increased.

There are many other questions associated with the subject under discussion which might be touched upon, and the subject involves a great many details. In brief, it may be stated, however, that the same laws and axioms apply to bridge construction as to other types of construction, and unless the bridge structure is placed on a sound foundation, designed with care, and built of the best materials and workmanship, the result will not only be displeasing to the eye, but will eventually prove a failure.

Effect of Gypsum on Embedded Steel

GYPSUM, although formerly supposed to have a corroding effect on steel, has latterly proved to cause no noticeable or harmful deterioration. At various times tests have been conducted to determine the exact effect of gypsum on embedded steel. For many years, gypsum tiles and slabs have been used for constructional purposes and an article in the Contract Record of Feb. 7, 1917, drew attention to a new type of reinforced gypsum roof. This material thus occupies an important place in the list of structural materials and certainty that not corrosion is caused to the reinforcing is essential to its wide adoption. Besides a load-bearing use, gypsum has been widely employed as a fire protecting medium for steel supporting members. Its use for this purpose has been allowed by building codes, the result of tests establishing its non-corroding properties.

In 1912 a fire test was made on a gypsum floor at the testing station of Columbia University for the city of Toronto. The floor was a 4-inch thick reinforced-gypsum slab. It successfully passed the test required by the New York Building Department—a four-hour load and fire test. After the test, the slab was broken up and the scrap exposed to the elements of the weather for about a year. An examination then disclosed the fact that any metal which remained embedded in the gypsum mixture was not corroded, but all metal exposed to the weather showed signs of active corrosion.

Another important test was conducted on a gypsum floor forming a theatre roof garden in New York City. The part cut into was under the stage near a tank of water used for diving purposes. This location was chosen, as disclosing the worst possible conditions, as the proximity of moisture would aggravate any corrosion that might take place. The reinforcement in the slab comprised ungalvanized S-hooks secured to I-beam flanges, to which were attached twisted galvanized wires forming the reinforcement. The steel and wire had been embedded for 15 years and when removed were in absolutely good condition.

Still further information as to the efficacy of gypsum in protecting steel is given by the Bureau of Standards of the United States, which has been conducting tests for some time on the protective value of various coatings on metal lath. The results as contained in a progress report are as follows:

The numeral 10 is assumed to indicate a perfect condition or no rust.

Type of Lath	Gypsum	Average of all plasters
Lath galvanized before expansion...	9.6	9.8
Painted "Special" iron lath	9.0	9.3
Painted steel lath	9.0	9.1
Sherardized lath	7.5	8.3
Unpainted "Special" iron lath	7.25	7.0
Plain steel lath	7.5	7.6

The above outlined experiences indicate that when gypsum is used upon metal lath or structural steel, no progressive corrosion can occur if air and moisture are prevented from coming in contact with the metal.

Electricity for Sewage Purification

By T. Chalkley Hatton*

THERE is a popular impression that electricity will accomplish about everything except the generation of human life, and a great many scientific investigators have spent time and money to adapt electricity to the purification of sewage, but so far with little practical result.

Men with but little knowledge of the vast complexity of sewage purification have developed apparatus and processes, upon which they have secured patent, for treating sewage electrically.

To assist them in introducing their goods to the public they have associated with them very able promoters who have been energetic in presenting the efficiency and economy of the process to many communities. The subject has, therefore, become too public to be altogether ignored.

The Electro Sanitation Company of Los Angeles, Cal., has introduced the electrolytic process developed by Mr. L. G. Lautzenhiser, which consists of passing crude sewage through a trough partly filled with electrodes placed at right angles to the line of flow and connected in parallel with a low voltage electric current.

In brief, the theory is that the applied sewage containing table salt, and other electrolytes is rapidly decomposed by the passing electric current, forming caustic soda, nascent chlorine, hydrogen and oxygen. Part of the chlorine thus set free combines with the soda, lime and iron, thrown off from the electrodes, forming hypochlorites which attack the organic matter and destroy the bacteria.

This process has been installed in several small communities in Texas and California. The Milwaukee station experimented with it for some months, under the direct supervision of Mr. Lautzenhiser, but abandoned it as unsuitable to Milwaukee conditions.

A few years ago Mr. C. P. Landreth, of the city of Philadelphia, a gentleman engaged in the manufacture and sale of belting, invented an apparatus for the purification of sewage by electrolysis. This machine has recently been tried out at Elmhurst Sewage Disposal plant in the Borough of Queens, New York, the Chicago Stock Yards, and at Decatur, Ill.

It differs essentially from the Lautzenhiser apparatus in that a rapidly moving paddle is introduced between each electrode to keep its face well scoured and sewage agitated, but the theory of treatment is the same, so far as the electrolysis is concerned.

In order to affect the standard of purification sought by those interested in introducing this apparatus, large quantities of lime are added, and whether it is the lime or the electrolysis which is the most influential agent, is a matter of disagreement among engineers; but whichever way this discussion may be finally settled, the cost of such treatment, so far as reliably published, has not attracted the public to any extent.

Based on the treatment of one million gallons of sewage treated, the cost at Elmhurst was estimated to be $30.19. On the same basis, the cost at Decatur was $18.85.

In passing from a discussion of this process of sewage treatment, the author wishes it understood that in spite of the negative results so far obtained in treating sewage by electricity, he believes that this force will eventually give more positive and encouraging results, but he does not look for such until the expert electrician, sanitary chemist and engineer get together upon a serious study of the problem.

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* From a paper read before the Western Society of Engineers.

Percentage System in Building Work

By G. D. Crain, Jr.

THE extent to which the percentage system of handling building contracts is being used, especially on smaller jobs, such as residences, is indicated by the fact that one of the leading building concerns of a southern city reports that over 90 per cent. of its work is now being done on that basis.

An interesting discussion of the merits of the plan is contained in a letter sent out by the company to its customers, in which the following language appears:

"We all agree that what the average person wants when making a purchase is to get his money's worth. He is willing that the seller should have a legitimate profit over and above his cost of material and labor and expense of conducting business. We want you to get acquainted with our method of building.

"Building, like other lines, has undergone changes in recent years. Formerly competition was so keen that many builders, in order to get work, simply neglected the matter of overhead, and undertook work that caused them losses, and then wondered why they made no better progress. We have gotten away from that and are following largely the cost-plus-percentage method to the satisfaction of a large number of our clients. The fact of the matter is that at present over 90 per cent. of our large volume of work is being done on this plan.

"By this method we guarantee our figures and you have the advantage in the first place of knowing the maximum amount that you will have to invest, and then of enjoying the anticipation of a possible saving, as in nearly every case we have effected one, ranging all the way from 5 to 20 per cent."

The system, as indicated, involves taking the work on a basis of the cost-plus-percentage, which includes overhead, supervision and profit. The amount of the margin varies, but 15 per cent. is about the average at which most jobs of this kind are handled. The maximum figure which is named on the job is usually the architect's estimate; and while one possible advantage of the percentage system, from the standpoint of the builder, is that he is protected in case of unusually expensive features unexpectedly developing, the company above referred to has found that the estimate is ordinarily sufficiently liberal to enable it to be used as a maximum basis on which to figure the work.

The defects of the system of competitive bidding are obvious. The man who knows least about the cost of doing the work is often the successful bidder—for this reason. The percentage system enables the owner to discriminate and to select the concern which has earned a reputation for good work and reliability, as he is then protected from excessive costs by the arrangement described. In other words, a premium is put on good work, rather than merely on the ability to bid low.

The average owner is willing that the contractor make a fair profit on his work; and it is also plain that if a contractor sees that he is likely to lose money on a job he will be tempted to "cut the corners" wherever he can for the sake of making his net loss as low as possible. This does not always happen, of course; for many concerns would rather lose money on a piece of work than risk losing the good-will of the customer. Nevertheless, the temptation to slight the quality, when it is found that a bid which is too low to cover the cost has been made, is present, and it doubtless has its effect in a good many cases.

On the other hand, the very fact that the wise contractor appreciates the risk involved in bidding, since it is never possible to anticipate every feature which may arise, means that a larger margin must be allowed to take care of the unknown quantities than would be necessary if every point were covered by the bid. The contractor who would be willing to make 15 per cent. "for sure" on every job will probably allow 25 per cent. in bidding in order to take care of the unexpected difficulties that may arise, and also to take care of other jobs where the net had been considerably below the expected profit.

That means that in some cases the owner pays more than a fair price for the job. He is helping to average up the general run of work, and his excess payment offsets the too small amount charged on an unprofitable job. This is obviously an inequitable system, and furnishes a legitimate argument for the use of the percentage system.

One of the chief advantages to the contractor is that suggested above. He can get the benefit of accumulated good will and the prestige which goes with a record of big jobs well handled. While it is not necessary that the architect let the contract in every case to the low bidder, the inclination is always in that direction; and thus the inexperienced and the unskilled, who know neither how to figure the cost of a job nor how to handle it to the best advantage, are likely to get work to which those who have proved themselves in previous jobs are really entitled. That is one of the glaring weaknesses of the present system. The lowest and best bidder is the man to whom the contract, in theory, should be awarded; but in actual practice it is more often the low man than the best man who gets the business. Contractors have learned this, and know that only when their bid is pretty close to the bottom will they be given serious consideration.

It must not be thought, however, that the percentage idea solves all problems and makes life's path easy for the contractor. There are difficulties and irritations involved here as well as under any other system, for no change in methods will change human nature. The contractor who is inclined to beat the owner under a bidding system will probably attempt the same thing under a percentage plan.

In fact, cases have been cited in which the contractor padded his expense bills, charging the owner with the list price for material, without showing the discounts received. Time for labor was also increased, helpers being put in at full wages, and other features of that kind developing. Carelessness in buying and using material when the owner is footing the bills is also apparent in some jobs handled on a percentage plan, and when this occurs the system is given a bad name.

Another difficulty is determining just what the percentage should be. And, after all, here is an opportunity for bidders to be pitted against each other; for the man who agrees to do the work for the smallest percentage over and above the cost of material and labor, other things being equal, is likely to get the job. So adopting this plan does not entirely solve the problem.

"The percentage system has been given undeserved unpopularity among certain owners and architects," said a well-known builder recently, "because of their experience in dealing with contractors who did not play fair. It might be said that under such a system the owner would be foolish to give his work to anybody except those whom he knows he can trust completely. But if one man is willing to work for a smaller margin than another, he is likely to be given the contract. The contractor of this kind may think that it is legitimate to make up for a narrow margin of profit by padding his bills and get his profit in some other way; but we believe in laying all our cards on the table and stating at the beginning just what the charge is going to be, above the cost of labor and material."

Taking it all in all, and in view of the experience of leading concerns like the one cited in this article, it seems that the percentage system is making good and has come to stay.—The National Builder.

Engineers Handling Questionnaire

In connection with the distribution of questionnaires in Montreal, a meeting was held at the rooms of the Canadian Society of Civil Engineers on May 10, Prof. E. Brown presiding. The city of Montreal has been divided into 30 districts for the purpose of securing information from nearly 1,500 firms, etc. The following captains of teams are appointed: Messrs. E. Marceau, A. Surveyer, J. C. Smith, J. M. Robertson, R. M. Wilson, deGaspe Beaubien, J. T. Farmer, J. S. Costigan, O. O. Lefebvre, H. Rolph, K. B. Thornton, F. B. Brown, C. E. Fraser, W. D. Black, F. H. Pitcher, A. F. Byers, R. deL. French, G. R. McLeod, W. W. Plumb, M. Beullac, A. R. Roberts, H. Y. Russell, J. W. Bell, J. A. Dresser, Capt. J. G. Ross, Leo. Ryan, C. A. Hazen, J. A. DeCew, Lt.-Col. C. N. Monsarrat, and Dr. Milton Hersey.

Progress on St. Maurice Dam

The St. Maurice Construction Company, Montreal, are making rapid progress with the St. Maurice dam being built for the Quebec Streams Commission. About 15,000 yards of concrete are now in place. The main channel of the stream has been unwatered by means of cofferdams, and concrete work was started on April 18th for this portion of the work. Sir Lomer Gouin, the prime minister of the province, in company with the Hon. S. N. Parent, the chairman of the commission, visited the work during the past week.

Looking at Shipbuilding Possibilities

Mr. T. S. Dickson, of William Beardmore & Company, shipbuilders, Glasgow, is in this country for the purpose of selecting a site for an extensive steel shipbuilding and dry dock plant. It has been definitely settled that a plant will be built in Canada. In company with Mr. A. D. Swan, consulting engineer, Montreal, Mr. Dickson has inspected sites at Montreal, Quebec, Halifax, N.S., and St. John, N.B.

Painting Exterior Concrete Surfaces

THE following recommendations regarding treating and painting concrete surfaces are by A. A. Kelly, in Cement World:

The life of cement is the alkali content; remove this alkali and the cement becomes worthless. It is the alkali that renders it difficult to get a satisfactory paint coat over a cement surface. Neutralize the alkali with an acid and the cement is weakened, the surface is soft. This was one of the earliest methods taken for treating cement surfaces, using diluted muriatic acid. This cleaned the surface and removed the alkali therefrom, but it at the same time converted the free lime into calcium chloride, injuring the surface, and making it liable to crumble. Sulphuric acid also had been tried, with the same result, of course. Moreover, enough acid remained after washing off to affect the painting, and it, too, was badly injured.

If a cement surface is allowed to stand to the weather for a year or more the weather will neutralize the alkali, and the cement will have become dry, an important consideration. This method is far better than the acid application, but one should not figure on having a cemented surface or stucco-house, or other structure painted at once, upon completion.

Zinc Sulphate Treatment

The McNicholl process seems to be the best treatment yet devised for coating a fresh-cemented surface. It consists of zinc sulphate, five pounds to the gallon of soft water. The zinc sulphate forms a chemical compound that prevents the alkali from attacking the paint coating, afterwards applied. This process is also good for interior walls, over Keene's or Portland cement. When it is dry apply a coat of either pure raw linseed oil or an oil paint, thinned out with benzine. Some use a common varnish size, instead of paint or oil, it being cheaper, but the oil or paint is better.

Another formula calls for equal parts of water and zinc sulphate, which is applied on the dry cemented surface, using a stiff bristle brush. This coating will have become hard in three or four days; the zinc sulphate having changed the caustic lime of the cement into calcium sulphate or gypsum, and zinc oxide has been deposited in the pores of the cement. When oil paint is subsequently applied it becomes incorporated with the zinc coating and forms a lasting coating. Zinc sulphate has no known injurious effect on concrete or cement surfaces, consequently there is no disintegrating chemical change set up. The process has proven a decided success.

Another treatment for the cement surface is to apply a solution of 10 pounds of carbonate of ammonia to 45 gallons of water. This forms insoluble calcium carbonate on the surface of the cement, and a large amount of ammonia is liberated, leaving a good surface for paint. This does not injure the cement, but where mortar containing lime is used in doing stucco work it is better to use two weak solutions of this wash than one strong one.

Correct Method of Painting

The following is a correct method for painting on cement:

The priming coat: One hundred pounds white lead, in oil; 4 gallons pure boiled oil, and 1 gallon turpentine; or in place of boiled oil use 9 gallons pure raw oil and 3 half-pints of japan.

Second coat: One hundred pounds white lead in oil; one-third boiled oil and two-thirds raw oil, and 1 pint japan drier, or 4 gallons raw oil, and the japan.

Third and last coat: One hundred pounds white lead in oil; one-third gallon boiled oil and two-thirds raw oil, or 3½ gallons raw oil, 1 pint turpentine, and same of japan.

Red lead is a good pigment for painting over cement, using 85 pounds dry lead oxide to a gallon of boiled oil, and 1 quart of turpentine. Red lead makes a more elastic paint than white lead, and seals up the pores better, but the red is not desirable under light paints.

Another method for painting over the zinc sulphate treatment consists in using a paint thinned only with turpentine, with a little varnish to serve as a binder. The second coat is the same. The third coat should be thinned with a mixture of three parts boiled oil and one part pure turpentine. The next and last coat should be thinned with turpentine only, with a little varnish for a binder. This would give a flat or lustreless surface, desirable in some instances.

In painting over cement it is thought by some experts that considerably more turpentine should be used than in any ordinary painting, and use very little japan driers. As to oil, the boiled is thought to be preferable to raw. In the priming, the paint should be thin, using turpentine and no oil, although each succeeding coat may have a little more oil than the one before it. It is also important that each coat be given ample time for drying before the next coat is applied.

Suitable Pigments

As to the pigments that may be safely used in painting over cement or concrete surfaces we have the following: For buff, use yellow ochre. For light yellow, use zinc chromate or zinc yellow. For red, use iron oxide. For blue, use ultramarine; the sulphate ultramarine by preference. For green, use ultramarine green, or oxide of cromium green. For white, use zinc white; the oxide or sulphide (lithopone). For black, use mineral black, black oxide of manganese, black oxide of iron. For gray, use both graphite and lithopone, or lithopone and mineral black.

Concerning the waterproofing of cemented surfaces a number of special coatings have been placed on the market, with the claim that they will withstand the action of alkali. This ensures a paint from destruction when applied over the cement. But it appears that in some instances at least the claims are largely overdrawn; their waterproofing qualities at any rate. It is very easy to test any waterproofing liquid. Take a porous brick, one that will fairly represent the cemented surface as to porosity, and apply to it as many coats of the liquid as you would apply to the cemented surface, and let each coat have ample time for drying. When the coats are all quite dry, weigh the brick, and make a note of its weight. Then place the brick in a vessel with water enough to cover it. After twelve hours take out the brick and wipe off surplus moisture; then weigh and compare with weight taken in the first instance. The difference in the weight will show the amount of water taken up. Such tests must, of course, be made carefully, in order to obtain accurate results. Let the brick in the first place be perfectly dry, and see that the coatings entirely cover its surface. Let each coat have plenty of time for drying, and weigh carefully. This is a simple and very conclusive test.

A Protective Liquid

It is often desirable to use a protective liquid that will not alter the color of the cemented surface. The use of paraffine, applied hot, and the surface also heated, to enable the paraffine to enter more perfectly, has long been used, and very satisfactorily. Some think nothing can be better for coating cement or concrete than this simple substance, as it is unaffected by alkali or acids and is waterproof; at the same time it does not affect the cement in any way, being neutral and colorless.

Bituminous Material in Road Work

The Construction and Maintenance of Various Types of Road Surfaces Involving Bitumen in Some Form — Sand Oil Roads

By W. R. Farrington[*]

A CONSIDERATION of bituminous road and street work divides naturally under two general heads—construction and maintenance. Under construction we will consider bituminous concrete, bituminous macadam, and bituminous surface treatments.

Bituminous Concrete.

Any discussion of bituminous concrete would, of course, be incomplete without some mention of sheet asphalt. The details of this type of construction are familiar, however, since this pavement has been in common use in the largest cities for at least 20 or 25 years, and has given excellent service.

Surfaces or pavements constructed under the "Topeka specifications" and similar pavements are apparently increasing in favor for roads and streets carrying heavy travel, and where, for various reasons, it is not considered advisable to use sheet asphalt or to pay the royalty on patented pavements.

These pavements differ from sheet asphalt largely in the size and grading of the aggregate and to some extent in the hardness of the asphalt or oil asphalt used. In some localities tar is being used in place of asphalt or oil asphalt, the advocates of tar claiming for it less cost for the material and also greater ease and hence less cost of mixing.

Broken stone and various bituminous materials are being used quite extensively, with good results, on the heavier traveled roads outside the cities. The usual form of construction is a base of broken stone from three to five inches thick, after rolling, the voids in this course being filled with stone dust, screenings, or sand. The top, or wearing course, which should be from two to three inches thick, after rolling, consists of broken stone, mixed with bituminous material. In some cases the stone, as well as the bituminous materal, must be heated to insure good results. The lake asphalts, oil, or residuum asphalts and tar are used for this work. Just enough bituminous material to thoroughly coat the stone should be used. Less bituminous material means possible disintegration, due to lack of bond, and too much is likely to result in too heavy a coating and eventual rolling of the surface.

The same advantages are claimed for tar in this work as mentioned under "Topeka specification" pavement, while the advantage claimed for the asphalts is less cost of maintenance. Under similar travel and conditions, the tar road will require more frequent sealing than the asphalt road, but it is only fair to state that the cost of resealing is small. The advocates of asphalt also claim that, even with a seal coat, the tar will lose its life sooner than asphalt, and, consequently, that the asphalt surface or pavement is a more permanent one.

Sand and Asphalt or Oil Roads

While sand and oil roads have attracted considerable attention, there is evidently more or less misunderstanding about them. Apparently some parties have assumed that these surfaces would prove a panacea for all road troubles, while others have considered that the sand and oil work was an endeavor—and not a very successful one—to imitate or approximate sheet asphalt, "Topeka specification," or similar pavements. Neither view is correct. These surfaces, as constructed with the sand usually available, and without the addition of other aggregate, will not carry a large amount of heavy travel, especially if the proportion of horse-drawn vehicles is large. Experiments are being made, however, including the addition of cement and stone dust, and the results apparently warrant the belief that some combination will be found eventually which will result in a surface that will carry heavy travel economically. The present idea is a base of the ordinary mixture and a wearing surface of the stronger mixture. Such a surface will not be a cheap one, but it is expected that the cost will be considerably less than that of sheet asphalt and similar pavements.

Sand-Oil Surfacing Methods

As to the details of construction, the usual outfit for sand-oil surfacing consists of a mixer similar to a concrete mixer, with charging device, and in most cases equipped with a hot attachment, and a mechanical drier. These drums are similar to the drums used with asphalt plants, but the flame, instead of being thrown between the drum and a jacket, as is customary with asphalt plants, is thrown either directly into the end of the drum (which is not jacketed) or into a combustion chamber at one end of the drum. The asphalt or oil asphalt is heated in kettles before mixing. Where the ordinary hot attachment is used the oil is poured into the mixer through the flame. This fact has led some to believe that the bituminous material must be burned, and that the roads will inevitably fail for this reason. However, roads in use between four and five years do not show signs of deteriorating as yet. The reason the bituminous material is not burned is probably lack of sufficient oxygen in the mixer to cause combustion.

The sand and oil mixture is spread usually in one course, shaped with rakes, and immediately rolled, first with a horse-roller and then with a tandem steam roller, in the course of a few hours. Before rolling with the steam roller, and, if necessary, during this rolling, the surface is reshaped with a road machine, to remove any inequalities developing during the preliminary rolling.

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[*] Division engineer, Massachusetts Highway Commission, before American Road Builders' Convention.

The best results have been obtained with oil asphalts having a penetration of from 90 to 125. If the grains of sand are rounded, and especially if the size of the grains varies little, as with ordinary beach sand, a very heavy oil asphalt gives the best results. Ordinarily the best results have been obtained by the use of about 16 gallons of oil per cubic yard of sand, loose, or about 18 gallons compacted. With this, as with other mixed work, just enough bituminous material should be used to thoroughly coat the aggregate, hence the finer the aggregate the larger the amount of bituminous material needed. The depth should be not less than four inches in the centre and three and one-half to four inches on the sides. Before the completion of the work a seal coat should be applied, using about one-half gallon of fairly heavy hot oil per square yard, with sufficient sand to take up the oil. Two one-quarter gallon applications of oil are preferable to one one-half gallon application.

Bituminous Gravel Carries Heavy Traffic

Gravel and oil, or bituminous gravel, is in some respects even more promising than sand and oil, and, as now constructed, will apparently carry quite heavy travel economically. The methods followed in constructing bituminous gravel surfaces are similar to those described for sand and oil, except that a larger proportion of bituminous material is used—ordinarily from 20 to 22 gallons per cubic yard.

Either mixed sand and oil or bituminous gravel can be used to good advantage for resurfacing old water-bound macadam or gravel surfaces.

Bituminous Macadam.

Under bituminous macadam we will consider broken stone penetration work and also, in this connection, sand and oil layer roads.

The cost of the penetration method is less than the mixing method, even though to obtain good results it is necessary to use rather more bituminous material. Also it is believed that there is less chance of failure if the workmen are not expert. In addition, the cost of a suitable mixing outfit is considerable, and the bituminous material for mixing usually has to be shipped in barrels, and so costs quite a little more than for penetration work.

With penetration work the voids in the first course of stone—which is usually three or four inches thick after rolling—are filled with stone dust or sand. The wearing course of stone, from two to three inches thick, is spread, rolled, and grouted with the bituminous material, from one and one-half to two gallons per square yard being used for this part of the work. The surface is covered lightly with pea stone or sand, preferably the former, and thoroughly rolled. Before the completion of the work the surface is cleaned by sweeping and a seal coat applied. For this about one-half gallon of the bituminous material is used, and covered with pea stone or sand.

Double Penetration Requires Less Material

The so-called double penetration method has also been used to some extent. Under this method the wearing course is formed by successive layers of stone with an application of bituminous material between each two courses and with a seal coat. The advantage of this method is that less bituminous material is required, and the principal disadvantage is the necessity of using small stone for the wearing course.

Another method of penetration is to mix sand with the bituminous material before it is applied. This method gives good results, but the cost is greater, and the surface is usually not quite as even as with ordinary penetration work.

While the first cost of such a surface is greater than of one constructed by the ordinary penetration method, the results so far indicate that the surface will last longer, that resealing is not necessary as often, and that the cost of maintenance will be less.

Sand and Oil Layer Work.

In connection with penetration work some mention of sand and oil layer roads would seem pertinent. In constructing a road by this method the subgrade is shaped and any sandy places hardened with sandy loam or clay. One and one-half gallons of a fairly heavy hot oil, similar to that used for hot blankets, is put on per square yard in two applications, or two gallons in three applications. Sand is spread after each application and the surface rolled with a horse roller. The one and one-half gallon treatment should give eventually a thickness of about three and one-half inches and the two-gallon treatment about four inches.

If only one and one-half gallons are used it will probably be necessary to apply about one-half gallon the following season. On the whole, this method is preferable, as any surface constructed of sand and oil by the layer method will be more or less out of shape for some time after the oil is applied, and weak places will develop. By delaying the final application of oil until the following season the weak places can in the meantime be strengthened and the surface evened up by scraping with a road machine.

The layer road will carry only light traffic, and is a suitable type of road only where the conditions will not warrant a more expensive surface. On the other hand, where sand is available and the traffic light, such a road can not only be constructed at a comparatively small cost, but can be economically maintained.

Bituminous Surface Treatment.

To some it may seem that bituminous surface treatment, except as auxiliary to mixed or penetration work, etc., is, or ought to be, largely a thing of the past. It is a fact, however, that in certain localities the travel and financial conditions will not warrant even as expensive construction as mixed bituminous or penetration surfaces. For such conditions water-bound macadam or gravel surfaces, with an oil or tar blanket, are suitable.

Maintenance.

As to the maintenance of sheet asphalt and similar pavements, the writer would only state that to properly patch such pavements the old material must be cut out to the base or for a depth of at least two inches and the sides of the hole be left fairly straight. The hole should be filled with mixed material similar to that used in construction, and this material should be thoroughly tamped or rolled. An asphalt smoothing iron can also be used to good advantage.

A surface constructed of broken stone and bituminous material by the mixing method should probably have a seal coat applied after some years, as the road metal becomes exposed and resealing will be necessary sooner and oftener with tar than with asphalt, as the latter tends to work up slowly and reseal the surface. Other ordinary maintenance consists in filling depressions.

Mixed sand and oil surfaces should be resealed occasionally—usually once in from three to five years, depending on the amount of travel. For resealing, either a heavy hot oil or the heaviest so-called cold oil can be used, from one-quarter to one-half gallon per square yard being required. If the surface becomes uneven it can be improved by scraping with a heavy road machine. Depressions in the surface should be filled with bituminous material and sand or pea stone mixed before placing. In resurfacng sand and oil roads at least two inches of new mixture should be applied, and if the old surface is much out of shape it should first be evened up, as any considerable inequalities will be reproduced eventually in the finished surface.

The methods of maintaining bituminous gravel surfaces are similar to those for sand and oil surfaces except that gravel should be used in place of sand.

Maintaining Bituminous Macadam

The maintenance of broken stone penetration surfaces is similar to the work on mixed surfaces except that in filling depressions the materials can either be mixed before placing or the stone can be put in the depression and grouted. The latter method costs a little less, and is satisfactory if the work is carefully done, but mixing is, on the whole, advisable. Penetration surfaces usually require resealing oftener than mixed surfaces, but ordinarily not over one-quarter gallon per square yard of bituminous material is required, so the cost is small.

Ordinary repairs on sand and oil layer roads consist of reshaping from time to time with a heavy road machine, filling depressions with sand and oil or pea stone and applying additional oil as needed.

In the maintenance of water-bound macadam and gravel roads bituminous surface treatments have for a number of years played, and without doubt will continue in the future to play, an important part.

Oil and Tar Blankets

The use of oil and tar blankets has caused some inconvenience and resulted in considerable criticism; but, while it is, of course, a fact that on heavily-traveled routes water-bound macadam and gravel surfaces are not economical, they will, without doubt, continue to be used in many localities, and are satisfactory for light travel. Consequently, bituminous surface treatments are of considerable importance.

At present it is the general practice in the writer's state to use for the first treatment about one-half gallon of oil, with a viscosity of between 40 and 50 sec., Lawrence viscosimeter, at 100 degrees C., followed in the second season with about three-eighths gallon of oil with a viscosity of about 100 sec., and the third season from one-sixth to one-quarter gallon of similar oil. After that not over one-sixth gallon should be needed, and retreatment will probably not be necessary every year. After the second or third year oil with a viscosity up to 200 sec. can be used to good advantage.

The methods of applying and maintaining tar blankets are similar to those for oil, but tar does not take up as much sand or other grit as oil, and hence does not form as thick a blanket. Tar does not tend to bunch as readily as oil, but requires more frequent and heavier retreatment.

Tar Paper on Concrete Floor Deadens Noise

TO deaden the noise from passing trucks rumbling over a concrete floor, a factory has successfully used a heavy tar paper pasted to the floor by paint. The method of application, as described by David Fliegelman, is as follows: The floor or aisle to be protected is first given one coating of gray cement paint. On the following day when the paint is thoroughly dry, a second coat is applied. At the same time one side of a five-ply tar paper is painted; and when both paper and floor are still wet, the pâper is carefully laid, wet side down, on the floor and rolled with either a roller or wide-tired truck until all signs of air-pockets beneath the paper disappear. The surface seems to improve with age and very effectively reduces noise at a low cost.

Split Log Drag Causes Improvement

Good roads conventions are excellent. Much information and many helpful suggestions are to be obtained from attending them. Unfortunately, very few country pathmasters attend them. We all hope that, eventually, good roads, with proper surface and underdrainage and foundation, will become general. Meanwhile it would be well for us to exercise the proper care that should be given to many existing earth roads.

While travelling through Dundas County the middle of April it was distinctly noticeable that the roads upon which the split-log drag had been used were in decidedly better condition than the undragged roads. Do not wait until the road is to be reconstructed. Do something to keep it in good shape. If the split-log drag is used in the spring, or after rains, earth roads can be very much improved. Instead of having a road full of holes and ruts an earth road can be kept smooth and in much better condition than many of the undragged roads of the present day. The cost is small, but the improvement is great.—Conservation.

Concrete on the Farm

This has been called the age of concrete. The statement applies to the farm as elsewhere. Concrete floors and walls in a granary will keep out rats. Concrete floors in the stables will prevent the loss of the liquid manure and assist the farmer in the conservation of its fertility. Concrete is useful in curbing and covering the well to keep out dirt and disease. It can also be used for the floors of garages, which are rapidly increasing on farms. Other uses for concrete are numerous, but there is one purpose for which it is seldom used, i.e., laying a walk from the house to the barn.—Conservation.

Engineers on Active Service

A recent revision of the roll of honor of the Canadian Society of Civil Engineers shows that 755 men have enlisted and that 41 have been killed. This number does not include many members on military duty in Canada—only those at the front. An analysis gives 75 members, of whom 4 have been killed; 329 associate members, 18 killed; 151 juniors, 13 killed; 197 students, 6 killed; and three associates. The list is a sufficient testimony to the part that the engineers are playing in the struggle, and more than justifies the president's recent tribute to those who have gone overseas.

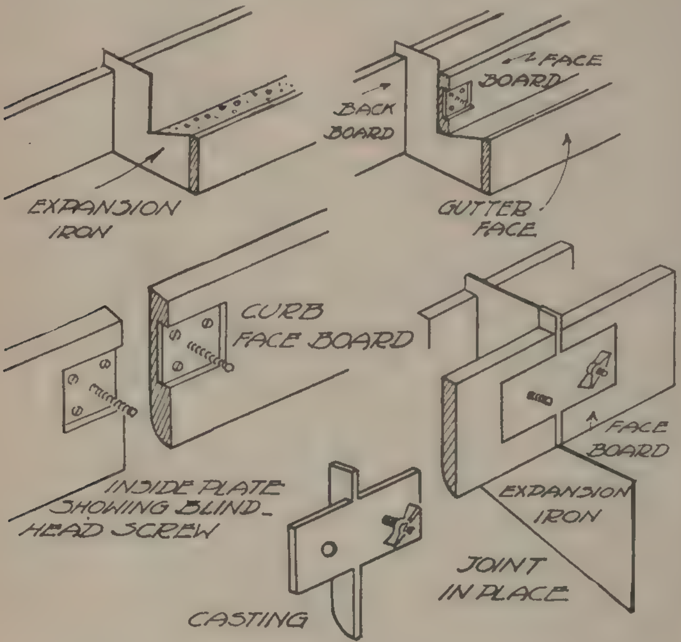
Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Curb and Gutter Forms Permit Easy Removal of Expansion Joint Plate

By J. M. Chappell*

I HAVE what I think is a good thing in the building of combined curb and gutter concrete. I have been at this kind of work for six years and in starting out I copied usual methods of construction, but I soon came to the conclusion that there was an easier way to get the expansion joint plate out than by taking down the front facing plank to allow the removal of the iron. I wanted to save the cost of one man facing up the curb, after the front facing plank came off. That way of finishing is not good for concrete anyway, as it should not be disturbed after it has been put in place, with a proper facing.



Home made curb and gutter form produces rapid, economical results.

I worked out the idea that is shown in the accompanying illustration. I used pine plank, 2 in. x 7 in., and got them molded out in the proper shape at the factory and cut them 8 ft. long. This is the length of the block in my city. I then set a stud in each end of the facing plank, as shown in the figure, having a casting made to fit in the end of the facing plank. This I fastened in with a thumb screw, which makes the form thoroughly rigid when ready for concrete.

When the sub-base is prepared and the back plank, 2 in. x 12 in., is put in place and securely fastened, any intelligent boy can finish setting up the forms faster than a crew of eight men with a small mixer can put in the concrete.

After the back form is in place the remainder is as easy as hanging clothes on the line, and you will have curb and gutter absolutely straight, with a proper grade, and no water remaining on it after it is done. Before the iron clamps are taken off, that is, the clamps that hold up the facing board, and while the concrete is deposited, a small piece of 2-inch board strapping is nailed on the face board of the gutter form to hold up the facing plank until the concrete sets, then back off the thumb screws, back off the casting, which only takes a few minutes; haul out the joint iron and the job is done.

My front facing planks I have used for six seasons and they are as good to-day as the day they came from the factory. By keeping them well oiled, they will last a long time. With this method of construction, when the form comes off, there is a good smooth face, and as the coarse aggregate and fine aggregate are all mixed together, there is no danger of crazing or hair cracking any time in the future.

George McKnight, city engineer of Fredericton, N.B., says: "I have used these forms this summer and find them very reliable, particularly the joint irons, which can be removed without disturbing the concrete in any way. The method used to fasten the joint irons to the form makes a positively level surface on the curb.

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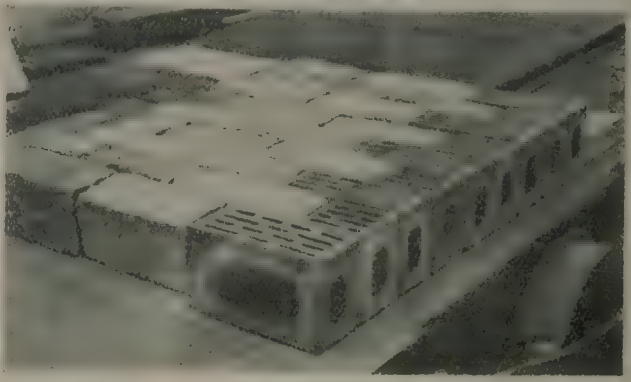
*Concrete contractor, Fredericton, N.B., in Concrete.

Cast Iron Curb Blocks Take Wear

SPECIAL cast-iron and concrete paving blocks designed by Edward A. Byrne, acting chief engineer, Department of Plant and Structures, New York City, for use along the curbs of bridge approaches, in place of the ordinary granite blocks, are described in the Engineering News Record. They have proved satisfactory under service and have fully justified their added initial cost. They were employed in connection with the repaving of the approaches on the Brooklyn Bridge, where it was found that the steel-tired vehicles using the curb for a brake on the steep grades of the approaches, concentrated the wear



Cast iron paving blocks at curb prevent ruts.

to such an extent that the blocks at this point were destroyed long before the rest of the pavement. The wearing was so irregular and produced such a series of ridges and depressions that vehicle progress was considerably interfered with, and any reasonable speed was impossible. Besides being a great annoyance to the traveling public, these blocks required frequent replacement.

The special block is cast hollow, with a top face 1 inch thick, and may be best described as an open box or crate, having ends and faces of ⅝-in. square metal. The blocks are made in two lengths, 4 inches and 8 inches, and are 5 inches deep by 4½ inches wide. Excessive smoothness is avoided by casting recesses in the top face. The hollow space is filled with concrete, which is allowed to set thoroughly before the blocks are placed in position in the pavement.

When empty the 4-inch blocks average 8 lbs. in weight, and when filled with concrete 12¾ lbs. The 8-inch blocks average 13¾ lbs. empty and 24 lbs. when filled. Laid in conjunction with granite blocks, they increase the cost of a 16-foot roadway about 10 per cent. over the price of a straight granite-block pavement.

New Design of Screen Chamber

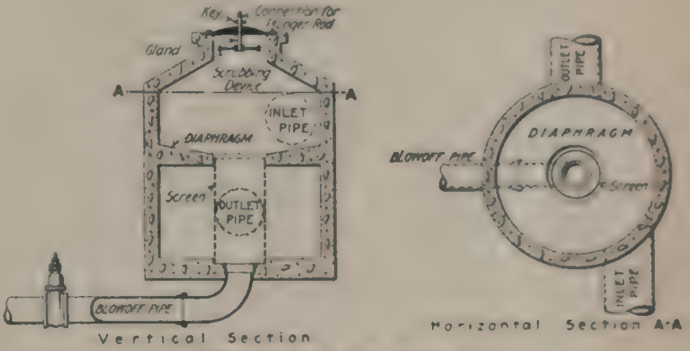
By John H. Lance*

ALL stream, reservoir and lake supplies require careful screening before the water may be admitted to the distribution system. Among the bodies to be removed from the water are gases, leaves, sticks, bits of bark, and fish.

The customary method of removing these substances is to install either a screen affixed to the pipe or else two screens in series, one of which may be drawn up out of the water for cleaning while the other is in service. The former arrangement, which is applicable only to very small depths of water on the screen, is economy itself in first cost, but its use has not always proved so economical; as owing to any one of many causes the screen might not receive the necessary attention at the very time when it was most needed. The latter necessitates a considerable structure to hold the screens in place and house them while being cleaned, besides the trouble and expense of cleaning.

To obviate these and other difficulties the pressure screen chamber here described was designed. It consists essentially (see illustrations) of a vertical cylinder divided by a horizontal diaphragm into two compartments; the upper, or inlet, compartment has communication with the lower, or outlet, through a circular opening in the diaphragm and thence through the meshes of an open-ended cylindrical screen resting in the lower compartment, of a diameter nearly that of the opening. The lower end of the screen is concentric with the end of a blowoff pipe with a gate valve on it, normally closed. The inlet pipe enters the inlet compartment tangentially, while the outlet may leave in any direction relative to that of the inlet, preferably in a radial position. Any flow from the inlet pipe sets up a whirling motion in the water in the upper compartment. In passing through the screen cylinder it has a circumferential as well as a downward motion, which, owing to the passage of water through the meshes of the screen, diminishes as the bottom of the screen is approached. The result of this is to confine, largely, the foreign matter carried by the water to a central cone the base and height of which are approximately those of the screen. The upturned end of the blowoff pipe being made of nearly as great a diameter as the screen, this results in an accumulation of debris directly in the pipe. When blocking of the screen has progressed to a point at which there is a noticeable loss of head at the screen—as measured preferably by a mercury U-tube or a differential gauge—the blowoff gate is opened; the head in the blowoff pipe is then reduced to zero, or nearly so, the hydraulic gradient from reservoir to screen chamber is increased, and the high velocity established is transmitted directly to the water passing diagonally downward over the face of the screen and out the blowoff pipe. Ordinarily, the cleaning of the screen is accomplished in about the time that it takes to open and close the blowoff gate. If it is desired to maintain a considerable continuous flow through the outlet pipe, the blowoff gate need not be opened wide, in which case the operation will require a longer time. Under no conditions is an appreciable amount of water wasted.

Also incorporated in the design is a hollow segmental brush, for use in cases when the screen does not get attention for such long periods that a deposit of small fish is not readily removed by the flowing water. For the intake pipes of pumping stations the devices are best set in batteries of two, so arranged that one can be put in service while the other is being cleaned. In this case the cleaning is preferably done by jets of high-pressure water directed downward from the edge of the diaphragm across the screen. Where electric power is available, the use of proper contact devices at the point of measurement of the loss of head at the screen will make the entire screening operation automatic, both for gravity and pumping supplies. For use with a gravity water-supply the devices have been found to operate most successfully between the heads of 40 and 60 feet, though there is no valid objection to their use at other heads, under certain conditions. The screen chambers are made entirely of reinforced concrete with the exception of the manhole cover, which is of cast iron.



New pressure screen chamber.

The principle of pressure screening, from which the design was developed, was first suggested by O. M. Lance, general manager of the Spring Brook Water-Supply Company. The operation of the screen chambers has been found to be so economical and efficient that they have been adopted as a standard by that company. As convenient, all twenty of its supply lines will be equipped with the new device, and the old sliding screens will be removed, only bar screens being left in place.

The application of this development is quite wide and covers a variety of uses.

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*Abstract of paper read before American Waterworks Association.

Activities of Ontario Joint Committee

The Joint Committee of Technical Organizations, Ontario branch, have just mailed letters to the technical men of the province, giving information on a number of matters which have been engaging the attention of the committee. One of the enclosures treats in a general way of the activities of this organization and its relations with certain governmental and military bodies. Another enclosure describes the work that has been done towards organized practical instruction for the returned soldiers; in this connection a form is enclosed to Toronto members asking for volunteers who will give part of their time to interviewing and conversing with soldiers with a view to determining what particular work they are best fitted for. A third enclosure refers to the return of the questionnaires.

As the information contained in these letters is of general interest to many of our readers who may not be on the calling list of the Joint Committee, some of them are printed below:

Letter re Aiding Returned Soldiers

"The Joint Committee, after consultation with the Soldiers' Aid Commission, has worked out a plan whereby the technical man can be of great assistance to the returned soldier. This plan will make it possible for the man who can spare an hour or so a week to assist. Is not this the opportunity you have been waiting for?

"A number of returned men are incapacitated in a manner that will prevent them from going back to their former jobs. They will have to be trained for new ones, preferably using their former experience and knowledge as a foundation. You have the technical and practical knowledge and could assist in the training of these men. Would you be willing to have a conversation with some returned soldiers, giving them an idea of certain phases of your work and find out from your conversation what class of work they could best be fitted into.

"This type of assistance would be invaluable and is urgently needed. Please fill in the form attached and return at once."

Letter re Questionnaire*

"As you may be aware, the Honorary Advisory Council for Scientific and Industrial Reasearch in Canada, who were appointed in November last, are desirous of distributing Questionnaires throughout the Dominion. The object is to obtain an inventory of the existing research equipment and also the needs of those engaged in the industries of the country. This object will be attained if the Questionnaires are accurately completed by those to whom they are sent.

"Experience in the States in connection with somewhat similar work showed that difficulties were encountered, which were only swept aside with the co-operation of the technical men acting through their organizations.

"The Advisory Council therefore decided to profit by this experience and approach the different organizations in the Dominion.

"To cut a long story short, your Joint Committee were asked to take care of the collection of the Questionnaire in the Province of Ontario. Subsequently, by arrangement, a section of the province—known as the Ottawa district—was handed over to a Joint Committee formed at Ottawa for the purpose.

"Having explained the whole matter briefly I now come to the main point, viz.:—

"Volunteers are wanted to interview manufacturers and explain the object of the Questionnaires and see that they are filled in and returned to the Advisory Council.

"What will you do to help in the work?

"Please detach the attached form and mail right away.

"In your immediate vicinity there will doubtless be manufacturers to be canvassed. If so, are you prepared to cooperate in the work?

"It is of the utmost importance to the future development of our country. Need more be said?

"We think not.

"Will you prove it?"

Voluntary Aid to Returned Soldiers

"For some months past we have been endeavoring to find a way whereby the members of the technical organizations can be of assistance to the returned soldiers. We have been able to reach a working basis with the vocational officers of the Soldiers' Aid Commission of Ontario and the Military Hospitals Commission, so that the returned soldier who needs special training in some technical work will receive tutoring by a member of one of the Technical organizations while he is convalescent, and, if necessary, pass through a form of apprenticeship in an industry that he is to make his life work. This arrangement has been finally decided upon as we find it is in this capacity that the engineer and technical man can be of most assistance.

"The final plans have been definitely made for the city of Toronto. We would suggest that in the other locations in the Province, each technical man find out what is the condition of the returned soldier question in his own location and see what can be done to solve it. If we can be of any assistance kindly put us in touch with the situation and we will do all in our power.

"The Soldiers' Aid Commission of Ontario, is, at the present time, seeking vocational teachers to man the various training depots for the returned wounded soldiers. If any technical men feel that they can give up all their time and take a permanent position with the Soldiers' Aid Commission along the line of vocational training, kindly get in touch with this office immediately; or if the technical men know of any good foremen who would be of assistance as vocational teachers, kindly send in their names.

"The 'returned soldier' question is one that is of the utmost importance to the welfare of Canada, and it is certainly the duty of all technical men to assist to the best of their ability in the solution of this problem."

The work of the Joint Committees in the province of Ontario is going forward rapidly. Mr. W. E. Segsworth has taken the chairmanship of the Executive and is giving practically his whole time to the work. The prospects are that the problems with which the Committee will be confronted in the near future will demand the assistance of a very large number of voluntary workers. For this work there can be no doubt the technical men of the Dominion hold themselves in readiness.

The Galt Building Products, Limited, has been incorporated with a capital of $40,000, headquarters at Galt, Ont., and will manufacture brick, tile, sewer pipe, etc.

The Imperial Flying Board have a large gang of men under Col. Robt. Low constructing a camp at Leaside for the flying corps. A considerable amount of water main and sewers will be laid and connection is being made between Leaside waterworks system and the city of Toronto mains. James, Loudon and Hertzberg are looking after the interests of the town in this matter.

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* This letter goes to members outside of the city of Toronto and the Ottawa district.

Board of Engineers Makes Report on Montreal Aqueduct Situation

The Board of Engineers recently appointed to make a report on the Montreal aqueduct situation has brought in a report, which we reproduce in part as follows. The members of the board are Messrs. H. E. Vautelet chairman; A. St. Laurent, and J. B. McRae. The appointment of this board follows the recommendation of a body of ratepaying engineers of the city of Montreal who recently opposed the continuation of the work on power development as originally planned on the argument that it would prove excessive in cost and also that the amount of power available was overestimated. The determination of the best course to pursue is complicated by the fact that some five million dollars have already been expended and a large amount of work initiated. Extracts from the latest report follow. The conclusions are dependent upon a number of conditions yet to be determined —for example, the liabilities to the contractors, the cost at which power can be purchased, etc.

The Present Project

The project in course of execution, following previous enlargements, consists in the development of the present aqueduct, to such dimensions and flow capacity as will enable the hydraulic development of 10,000 h.p. for the purpose of providing electrical horse power for pumping the water supply needed by the city and for street lighting. It will also supply the water for the city's fire and domestic services.

Before commencing these later enlargements, a lateral concrete conduit of a maximum capacity of 75,000,000 imperial gallons per day was built to ensure a continuous water supply for the city. A filtration plant with a daily capacity of 50,000,000 imperial gallons has also been built which it is intended, we are informed, to enlarge to a capacity of 100,000,000 imperial gallons per day.

The present aqueduct course is followed in its entire length in the scheme of enlargement.

The intake is situated on the St. Lawrence River, about one and one-half miles below the Canadian Pacific Railway Company's bridge, and the head-race or canal extends to the present waterworks station, a distance of 5.2 miles, where it is proposed to construct the necessary power house, for which no designs have as yet been made.

The head-race has a slope of 3.3 feet for the entire distance and a bottom width of 163.85 feet. It runs partly in earth and partly in rock material. The bottom elevation at entrance is 21 feet above city datum. The water surface fluctuates from elevation 36 to 43.

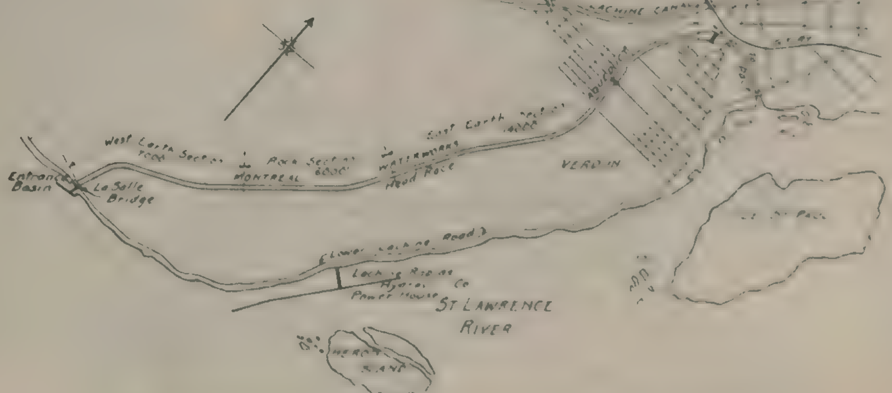
The tail-race, which extended from the present waterworks to the St. Lawrence River, opposite Nun's Island, has a total length of about 3,300 feet a slope of 4 feet, and a bottom width of 113.85 feet. The tail-race excavation will be apparently entirely through earth material. Elevation of the bed at the outlet is 2 feet above city datum; the water surface fluctuates from elevation 8 to 20; flood level has been as high as elevation 28.0. Both sides of the entrance canal, forebay and tail-race are lined with concrete retaining walls. No paving is provided for the earth sections of the head canal.

Paving for the bottom of the tail-race is provided for in the present contract, only for the basin below the power house, but we are informed that it is intended to pave the whole of the tail-race, and this paving will, therefore, be considered as part of the present scheme.

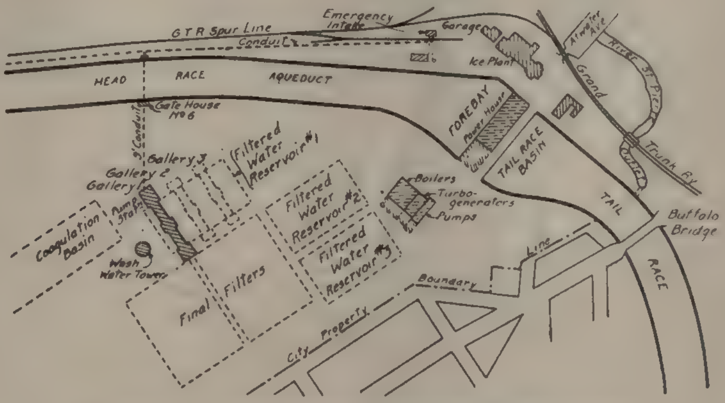
Status of Present Work of Enlargement

The city engineer, in a report to the Board of Commissioners dated December 16, 1916, estimates the total cost of the work, when completed, at $11,600,537.06, including cost of the work performed up to November 28, 1916, covering all contracts and expenditure since the beginning of enlargements. By deducting from the above the total amount of the cost of filtration works,, the cost of a pump built in 1908-10, and interest thereon, not chargeable to cost of power development proper, the city engineer arrives at the following figures for the power scheme:

Cost of work done to November 28, 1916, including interest	$4,013,510.12
Estimated cost of work yet to be done, including interest	5,581,647.48
Total	$9,595,157.60



General arrangement of Montreal waterworks aqueduct enlargement.



Montreal waterworks aqueduct enlargement (scheme No. II.)

The amount of interest included in the total is $1,404,550.

The cost of abandoning the work has been estimated by Mr. Mercier to be as follows:

Work done and interest	$4,013,510.12
Work to be done or payment to make bridges and fences	300,000.00
Ten per cent. on balance of Cook's contract	203,640.00
Power house and building to use the 7,000 h.p. purchased	340,000.00
Construction of another conduit or protection work	1,000,000.00
	$5,857,150.12

This is exclusive of large claims against the city in connection with this work, and which will require adjustment.

The present condition of the work for the entire aqueduct is as follows:

Work Performed

Earth excavation	about 50 per cent. done
Rock excavation	" 90 " "
Retaining wall, north side of entrance canal	" 48 " "
Retaining walls, south side of entrance canal	" 20 " "
Forebay and tail-race walls	nil
Entrance gates, contract yet to award	no work done
Supply conduit	100 " "
Expropriations of land required for boulevards, etc.	not completed

Method Followed in Carrying Out the Investigation

The needs of the city are: Power for pumping water at Atwater Avenue and electric current for water pumping stations, such as McTavish Street and Papineau Avenue; sewage pumping stations, filtration works, and street lighting. There are three ways of obtaining the needed power:

1. The establishment of a hydro-power station at Atwater Avenue (Schemes I., II., and III.).

2. Pumping by steam and buying electric current for other needs (Scheme IV.).

3. Buying electric current for all the needs of the city (Scheme V.).

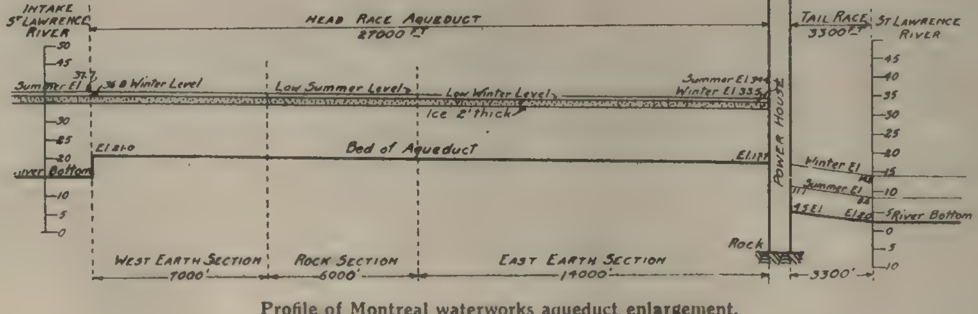
A start has been made towards the carrying out of Scheme I., and the adoption of either Scheme IV. or V. would necessitate discontinuing the works now in course of execution. We, therefore, had to estimate the cost of making the canal fit for such services as may be required.

If Work Discontinued

If the work be discontinued we have to consider two cases—A and B.

In case A (Scheme IV. and V.) the banks of the canal, where walls have not been built, are simply trimmed to a natural slope, without any attempt to secure straight side lines or regular curves, cutting down the expenditure for this purpose as low as possible, leaving the tail-race in its present state.

In case B (Scheme III.), to develop power, the banks of the canal are sloped in straight lines and regular curves, to



Profile of Montreal waterworks aqueduct enlargement.

ease off the flow, and the tail-race is enlarged to accommodate the discharge thorugh the head-race.

The cost of case A was found to be $5,895,000, and the amount of interest charged amounts to $1,072,948. This amount of $5,895,000 has, therefore, to be added to the cost of pumping by steam or by electric current.

If Work Proceeded With

If the work is proceeded with, we had again to consider two cases—case C, connecting the pumps directly to some of the turbines in the power house; case D, using all the power from the power house to produce electric current and then using part of the current to operate motor-driven pumps.

The total costs entailed by each scheme are outlined in Table I., herewith:

for different assumptions of the quantity of power obtainable from the canal, and for different methods of utilizing said power.

Our estimates do not include the cost of the filtration plant already built, nor of its proposed additions and operation, but include the cost of the power needed and the cost of heating. We have not included either the cost of the main suction and discharge pipes beyond the pump house, the cost of some of the bridges (as explained before), nor of the claims of the Cook Company. These costs would be the same for all schemes.

As for boulevards, which are provided for only in Schemes I. and II., we have included the cost of land, fences, and ditches, and whatever grading must be done by the contractor, and nothing else.

Table I.—Total Cost and Cost of Operation for All Schemes (Power Given in H.P.).

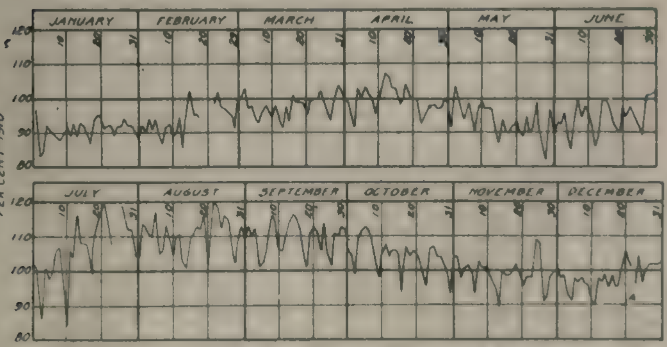
Schemes	Potential hydraulic power		Power development Pumping and electric power		Power development Heating	Total cost		Cost of operation	
	summer	winter	summer	winter	winter	actual	future	actual	future
I.—Present plan	11,900	7,445	10,500	10,500	Heating by exhaust steam.	$8,537,000	$9,177,000	$590,000	$679,000
II.—Maximum power available	24,500	13,000	13,000	13,000		....	10,609,000	.....	740,000
III.—Minimum power available	9,500	5,000	10,500	10,500		7,515,000	8,205,000	504,000	648,000
IV.—Pumping by steam	Nil	Nil	10,500	10,500		6,434,000	6,703,000	546,000	712,000
V.—Buying electric current—$30 per h.p. ..	Nil	Nil	10,500	10,500	1,400	6,102,000	6,268,000	565,000	712,000
25 h.p.	Nil	Nil	10,500	10,500	1,400	6,102,000	6,268,000	529,000	656,000

Remarks on Costs and Conclusions

It must be clearly understood that we have estimated the cost of the different schemes on condition that they be executed with despatch, in a businesslike way, and without undue delays.

We have found that the cost of putting the canal in proper shape if the work were discontinued, is $5,894,846, of which $1,072,948 represents interest. We had, therefore, to charge $294,742.30, being the interest at 5 per cent. per annum on the said cost, to the cost of pumping by steam or of buying electric current (Schemes IV. and V.).

On account of fluctuating rates and prices it is impossible at present to make an estimate of cost which would hold good for any length of time. This must not be forgotten in comparing estimates made as early as 1905 with those made now.



Daily pumpage as percentage of yearly average (54,625,462 gals. per day equals 100 per cent.) This diagram is compiled from records of low level pumping station.

The estimates referred to at the beginning of our report show a close agreement with our own, although calculated

In this report five schemes are considered. The figures used are taken from works lately executed, with a percentage added to cover normal increase in cost of labor and materials. The tables all indicate "present needs" and "future needs." We would direct your attention to the figures for "future needs" only, as such will be justified by the time the plant is ready for operation.

Cost of Schemes (H.P. Basis)

	Total cost.	Capital cost.	Cost of operation.
Schemes I.	$874.00	$756.66	$64.66
II.	816.00	716.06	56.90
III.	782.00	668.50	61.71
IV.	639.00	522.48	67.81
V. El. current at $30	597.00	493.05	67.81
V. El. current at $25	597.00	493.05	62.47
Work abandoned	562.00	459.22	28.07

The Schemes in Detail

We will now consider the schemes as described

Scheme 1.—Present Scheme

This scheme is the one to which exception has been taken, and we agree that it should not be proceeded with as outlined. It could not have developed the expected power.

Scheme II.—Maximum Hydraulic Development

This scheme shows the cheapest cost of operation per horse power. It is described at length in the body of the report and considered in our recommendations.

Scheme III.—Minimum Hydraulic Development

This scheme is inferior to Scheme II., and need not be considered. It gives less hydraulic power, and the auxiliary steam plant, being worked to a much larger extent, the possible increases in the price of coal will affect the cost of operation to a greater degree.

Scheme IV.—Pumping By Steam

This scheme considers finishing the aqueduct simply as a channel to carry water to the pumps, which are operated directly by steam. The high cost of operation is due to the charges against it of money already spent on the aqueduct extensions. Had the old aqueduct been left as it was—simply as a supply to the steam pumps—a steam pumping plant would have been a most attractive proposition.

Scheme V.—Buying Power

There are two subdivisions to this scheme, figured on electric power supplied at $30 and $25 per electric horse power, on the same basis as power is now purchased for pumping purposes. Here, as in the case of Scheme IV., the cost of operation is charged with the amount already spent on the aqueduct extensions. To this is added such expenditure as may be required to put the channel in condition to carry the water supply to the pumps. This scheme is again referred to in our recommendations.

From our examination we consider that it will be necessary to pave certain sections of the bottom between the walls, as a precaution against their sliding or turning over, due to the unstable nature of the ground. We have provided for such paving in our estimates.

Power for Lighting

There is not sufficient hydro-electric power in sight at present to justify your considering the taking over of the city lighting. This question has been treated at length in the body of the report.

Filters

The filters, as designed and now nearing completion, have a rated capacity of 50,000,000 imperial gallons per day. We understand that plans are under way for a further extension to 100,000,000 imperial gallons per day output, with possible future extension to 150,000,000 imperial gallons. The present records show a maximum pumpage of over 70,000,000 imperial gallons; this means that the filters have not sufficient capacity to meet the present demand.

Recommendations

Under ordinary conditions, and with the figures now before us we would have no hesitation in recommending the adoption of Scheme II., with provision for boulevards, as its cost of operation per horse power per year is the lowest. But, under the circumstances which have allowed of the contractor being able to prefer a claim of $1,469,338.17 on a contract of $3,012,562 on which work to the amount of $1,148,731.38 had been completed at the end of 1916, the question is different. We must also take into account the fact that the contractor has to be reckoned with for any changes or additions to the present plan.

We would, therefore, recommend:

1. That the south wall of the aqueduct be at once extended to the rock section, and that the west earth section be completed with paving where needed, as this should be done for all schemes.

2. That no work be done on the rock section nor on the east earth section until the final scheme is decided upon. This also applies to the tail-race.

3. That you immediately ask the several companies furnishing electric power in the city for firm bids on power. Carefully worked out specifications should be furnished to the power companies setting forth the exact conditions of the service required.

Prices should be, at the same time, obtained from the contractor for all changes and additions to the present contract.

As soon as this is done (and it could be done in a couple of weeks) you shall be able to come to a decision with full knowledge of the costs of operation of all schemes.

As all our figures will be in the hands of your chief engineer, he will be able to place before you the exact cost of each scheme.

In the meantime studies should be started and designs made for the proposed electric motor-driven pumping station. This station should be designed to pump the output of the proposed new filter plant which is to be 100,000,000 imperial gallons per day. Provision should also be made for future extensions. The equipment of this station will be the same whether you generate your own electric power or buy it. The plans for the steam standby station should also be put in hand. We have suggested that the new pumping plant be located on the south side of the aqueduct near the filters. This should provide a most convenient location for all piping connections. It also facilitates the connection of the steam standby to the heating system that is proposed for the filters.

No addition or alterations to the present steam pumping plant should be made.

The plans for the hydro-electric station may be delayed until you have come to a decision regarding the source of power.

We would also recommend:

4. That the lands required be secured at once, so as to prevent further delays to the work.

5. That the addition to the filtration works, at a cost of $900,000, as estimated in the annual report of 1915, be proceeded with.

Mainly Constructional

East and West—From Coast to Coast

Port Dover, Ont., is considering the installation of a waterworks and sewerage system. It is probable that a bylaw will be submitted to the people in August next.

A new charter has been granted to the Union Cement Company, of Owen Sound, Ont., the capitalization of the firm being increased to $1,000,000. The name of the company under the new incorporation is Union Cement, Limited.

The Board of Education of Campbellford intend to install new plumbing and build a sewer to the river in connection with improvements to the Public and High Schools. James, Loudon and Hertzberg have been retained by the Board in this connection.

The Toronto Board of Control have been discussing the possibility of having shipbuilding yards and plants established in the city. They have decided to confer with the Harbor Commissioners with the object of arranging for joint action in the matter.

At a recent meeting of the Delta council at Ladner, B.C., it was decided to construct a new reservoir about 100 feet up the hill back of the pumping station. This will provide an adequate pressure at night and also give a steadier pressure during the day.

The Mueller Manufacturing Company, Sarnia, are having plans made for a warehouse and contemplate immediate construction. Building is 65 feet by 129 feet, two storey brick and mill construction. James, Loudon and Hertzberg, are consulting engineers.

Mr. R. Lang, of Sault Ste. Marie, Ont., has been awarded the contract for filling the bridges and constructing the culverts along the line of the Algoma Central from Mile 18 to

Josephine Mines. There are three trestles to fill and the work will probably take till the fall to complete.

A contract has been let for one 1,000 G.P.M. domestic service electric pump for New Toronto to the Bawden Machine Company; for screens and screen frames to the Hepburn and Disher Company; for hot water heating system to the John Doughty Company, Mimico. James, Loudon and Hertzberg, are consulting engineers.

At a meeting of the Joint International Waterways Commission, held recently at the Federal Building, Detroit, the construction of a new channel in the St. Clair River at Port Huron was discussed, and the commission decided to approve the work. The proposed new channel will be for upbound craft and will be 7,000 feet in length, commencing at a point 1,500 feet above the mouth of the Black River and extending to within 1,000 feet of the international railway tunnel.

At a recent meeting of the Domestic, Sanitary and Heating Engineering Society at the Foresters' Hall, Toronto, President Fred Gentle presiding, the building trade situation was discussed and the general opinion of the members was that the outlook was far from encouraging. A resolution was passed calling upon the government to consider the advisability of assuming control of all minerals, and to investigate the general conditions surrounding the metal industries of the country.

A large deputation representing the towns of Whitby and Pickering and the townships of East and West Whitby and Pickering, recently waited on Hon. F. G. Macdiarmid, provincial minister of public works, and requested that the Kingston Road be taken over as a provincial highway under the legislation recently passed by the Ontario Government. They stated that they were willing to pay 30 per cent. of the cost of bringing the road up to the standard required by the provincial specifications.

The reconstruction of the Limoilou Church, Quebec City, which was burned down last fall, is expected to commence shortly. It has been decided to erect the new structure on the ruins of the old one, the walls of which are still standing nearly at their full height on solid foundations. An examination of the walls and foundations have shown them to be in a satisfactory condition and they will be used in the building of the new edifice. It is estimated that the cost of the work will be in the neighborhood of $200,000, and that it will be completed in two years.

According to the plan prepared by Engineer A. L. McCulloch, who is in charge of waterworks extensions and of the proposed sewer system for Trail, B.C., the length of the sewer required will be 20,990 feet, and the estimated cost is $37,200. The sewer will discharge into the Columbia River at the foot of Spokane Street, where the outlet was installed some time ago during the low water stage. These estimates do not include any part of the system that may later be required for Riverside Street, which Mr. McCulloch states will require a separate outlet.

A two-storey reinforced concrete building has recently been completed at North Dartmouth, N.S., for the French Cable Company, by the Standard Construction Company, Limited, of Halifax; also a pile wharf. The main building is 70 x 100 feet. It provides storage space for cables and accommodation for the officers of the company. On the ground floor are five tanks for storing the cables. Three of them are 10 ft. deep by 30 ft. in diameter, and two smaller ones are 6 ft. deep by 10 ft. diameter. On the second floor is another large storeroom. The wharf is 300 x 30 ft., having a shore crib of 100 ft. square.

A bill has been introduced in the B. C. Legislature by Hon. William Sloan, Minister of Mines, in regard to the establishment of public sampling and concentrating plants, customs smelters and refineries, and to make provision for the treating or buying of ores. Under it, the minister is empowered to cause enquiries and reports as to supplies of minerals and ores available in any district and as to the necessity of public aid in the mining or treatment of such and when such reports indicate that it is justifiable, that he shall have full power to secure sites, erect and operate public sampling works, concentrating plants, custom smelters or refineries, as he may deem expedient.

The plant which the Bunner-Mond Company propose building at Amherstburg, Ont., for the manufacture of alkali, will consist of five units of reinforced concrete construction. There will be a main building, 278 feet by 192 feet, with a tower 180 feet high, also a boiler house, lime kiln, warehouse and machine shop. It was decided to locate the factory at Amherstburg, where the company have purchased 700 acres of land, on account of the stone quarry and the rich deposits of salt in the vicinity. The stone quarry will be opened shortly. In order to prevent the pollution of the town's water supply, the company have been requested either to install a filtration plant or to pay for the removal of the town waterworks to a point above their factory. It is thought that a satisfactory agreement can be reached.

A by-law is to be presented to the ratepayers of Peterborough, Ont., on May 31st, to authorize the erection of a high level bridge over the Otonabee River at Hunter Street and a bridge over the river at London Street, has has been requested by the Quaker Oats Company. If the bridge is erected within a reasonable time, the company can rebuild their factory to conform to it, with the offices on the third instead of the ground floor, and would thus be saved any trouble by changes in the future. It would also eliminate the level crossing on Hunter Street, and facilitate their railroad connection arrangements. As regards a bridge at London Street, the city contemplate making use of the superstructure of the present Hunter Street bridge at this point, constructing 30-foot concrete spans at each side.

Personal

Mr. R. Talbot has been placed in charge of concrete caisson work at Three Rivers, P.Q., for the Shawinigan Water & Power Company.

Lieut. T. R. Buchanan, a graduate of the Faculty of Applied Science and Engineering of the University of Toronto, is reported wounded. Mr. Buchanan went to the front last year with the Engineers. He had taken up the mining branch of the engineering profession.

Lieut. Hugh E. Quinlan, reported wounded, is the son of Mr. Hugh Quinlan, of Quinlan & Robertson, Limited, general contractors, Montreal. He was on the engineering staff of the company, and enlisted with a railway construction corps. Lieut. Quinlan only recently crossed from England to Belgium. Another son, Lieut. Frank Quinlan, is with a construction corps in England

Obituary

Corp A E Downes, of the Canadian Engineers, a well-known Regina contractor, is reported killed at the front. He had been in France for a year

Mr. James Miller, a pioneer of Brock Township, Ont., died recently at Greenbank, after a brief illness. The late Mr. Miller was well known as a builder of barns, of which he erected a large number in the province, mainly in the townships of Reach and Brock He was born near Glasgow, Scotland, 76 years ago, and came to Canada when about three years old.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Anderdon Township, Ont.
Fred Mayville and Frank Jubenville plan tile drainage work.

Aylmer, Ont.
Town Council plan cement sidewalks on Warren Street. Clerk, D. A. Davis.

Batiscan, Que.
Rev. A. A. Belliniare, Dr. Eug. Ferron and A. Constentin will erect an aqueduct and reservoir costing approximately $10.-000. Owners are in the market for cement, crushed stone and cast iron pipe.

Blenheim Township, Ont.
Township Council plan drainage work. Clerk, Hugh Allan, Drumbo.

Bromptonville, Que.
Town Council will construct gravel road costing $3,000. Engineer, M. W. Veuilleuz.

Chicoutimi, Que.
By-law has been passed and tenders will be called soon for the construction of macadam roads costing $100,000 for the Municipal Council. Engineer, J. F. Trenon.

Edmonton, Alta.
City Council plan water extension costing $47,272. Engineer, A. Haddow.

City Council plan construction of sidewalks to cost $5,000. Engineer, A. Haddow.

City Council plan to grade roads at a cost of $8,000. Engineer, A. Haddow.

Howard Township, Ont.
Tenders received by the engineer, W. G. McGeorge, 153 Queen St., Chatham, until June 2 for drainage work for the Township Council.

Leamington, Ont.
Town Council plan reinforced concrete pavement on Chestnut Street. Contractor Smith has been asked to prepare estimates.

McKillop Township, Ont.
M. Murdie, Winthrop, plans drainage work, etc.

Mitchell, Ont.
Town Council plan cement walks on Rowland Street. Clerk, Wm. Ryan.

Montreal, Que.
P. E. Mercer, city engineer, and C. Cote, controller, in favor of installing garbage destructor plant to cost $1,-000,000.

New Hamburg, Ont.
Town Council plan concrete pavement, costing $16,000. Clerk, H. C. Edgar.

Petrolea, Ont.
Town Council plan pavement repairs. Chairman, Mayor McRobie.

St. Alexis, Que.
Tenders will be called soon for the construction of macadam roads costing $35,000 for the Municipal Council. Clerk, Jos. Belanger.

St. Catharines, Ont.
Tenders received by Chairman, Board of Works, until noon, June 5, for a gasoline engine, 10-12 h.p., two single stage centrifugal pumps and fittings, for the city. Plans and specifications with the engineer, W. P. Near, or P. Gillespie, Engineers' Building, University of Toronto, Toronto.

Tilbury North Township, Ont.
Township Council plan tile drainage work to cost $100,000. Clerk, H. J. Rocheleau, Stony Point.

Winnipeg, Man.
Street Commissioner, City Council, plans asphalting roads, at a cost of $15,000. Engineer, W. T. Brereton.

CONTRACTS AWARDED

Dereham Township, Ont.
C. Marone, care of Township Clerk, Alex. Bell, Dereham Centre, has the general contract for drainage work for the Township Council.

Colchester South Township, Ont.
Albert Gerard, care of Township Clerk, J. H. Madill, Harrow, has general contract for drainage work for the Township Council.

Listowel, Ont.
Frank Frost, Hanover, has general contract for 150,000 gallon concrete reservoir for the Town Council.

Notre Dame de Portneuf, Que.
The Quebec Concrete and Contracting Company, 14 St. Roch St., Quebec, have general contract for concrete sidewalks, costing $3,365, for the Municipal Council.

Ste. Foy, Que.
Laganiere Houde & Cie, Les Grondines, have general contract for macadam roads costing $145,000, for the Road Commissioner of Quebec, Parliament Bldgs., Quebec.

Toronto, Ont.
Fussell-McReynolds Co., Ltd., 1091 Dundas Street, have the general contract for construction of sewer on Pape Ave., for the Board of Control.

The Board of Control have awarded the following contract for pavements:—Grant Contracting Co., 50 Front St. E., brick block on Indian Grove, $2,751; Commissioner of Works, R. C. Harris, asphalt on Arundel, Cawthra, Monarch and Indian Grove, $24,776.

Windsor, Ont.
Adams & Olandi, Dougal Ave., have general contract for construction of sewer costing $9,959 for the city.

The City Council have awarded the following contracts for the construction of reinforced concrete pavement and curbs : — Victoria, Ellis, Bruce and Church, $44,329, C. W. Cadwell Sand & Gravel Co., 84 Sandwich St.; Montmorenci, Marentette and Elsmere, $16,900, Merlo, Merlo & Ray, 196 Windermere Road, Walkerville.

Railroads, Bridges and Wharves

Colborne Township, Ont.
Township Council plan erection of bridge at Benmiller. Clerk, R. McIlwain, Carlow.

Edmonton, Ont.
Canadian Northern Railway plan station. Engineer, Mr. Fraser.

Goderich, Ont.
Dominion Government plan new docks, piling and dredging.

Hamilton, Ont.
Canada Steamship Lines, Ltd., 9 Victoria Square, Montreal, plan drydock to cost about $250,000.

Pipestone, Man.
Tenders received by the secretary-treasurer, A. P. Power, Reston, until June 2 for erection of bridges and culverts for the Rural Muicipality.

Quebec, Province of
La Cie d'Enterprises Publiques, Levis, have the general contract for dredging River St. Maurice, Western Channel, for the Provincial Government.

Saskatchewan, Province of
Tenders received by Deputy Minister of Highways, H. S. Carpenter, Regina, until 6.30 p.m., June 11, for construction of two reinforced concrete bridge abutments at Ravenscrag, Swift Current, Moose Jaw Creek and Carieville. Plans with the Deputy Minister. Plans being prepared for two reinforced concrete arch bridges over Qu'Appelle River and Arm River.

Tansley, Ont.
Tenders being received by the clerk, Wm. Panton, Milton, until June 11 for $60,000 bridge over Twelve Mile Creek for the Halton County Council. Alternative designs may be submitted. Plans and specifications with engineers, Bowman & Connor, 31 Queen E., Toronto.

Toronto, Ont.
Toronto Street Railway will construct branch line costing $175,000 from Queen Street bridge to Ashbridges Bay.

CONTRACTS AWARDED

Notre Dame de Lourdes, Que.
Rousseau & Mathieu, Laurierville, are general contractors for $4,800 steel bridge.

Antigonish County, N.S.
Daniel Gillis, Glebe Road, has the contract for the erection of the McIsaac

ESTABLISHED 1886

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Principal Contents

Page
Editorial 491
Standard Bridge Designs for Ontario 493
Trenton Collegiate 496
New Theatre at Montreal 497
Compensation for Submitting Tenders 498
War Opens up New Trade Opportunities 499
Patricia Bay Ferry Slip 501
Handling Stucco to Get Good Results 502
Concrete Poles by the Centrifugal Method 503
Chlorine Made by Montreal Water & Power Company at Considerable Saving 504
Proportioning Concrete by Specifying a Definite Volcentage of Cement 506
Practical Hints for the Contractor 508
Mainly Constructional 509

Is Canada British? Enforce Conscription and Find Out

THE announcement of Premier Borden that he will authorize the raising of the necessary recruits, by conscription, to keep Canadian battalions in France at least up to present strength, is receiving, without doubt, the hearty approval of the vast majority of Canadian citizens. The most unsatisfactory and distressing feature of recruiting methods in the past has been the unfair distribution of responsibility and sacrifice which the voluntary system involves, both individually as citizens and collectively as provinces. The next most important objection to the voluntary system is its inefficiency, partly due to wasted energy in obtaining recruits, partly to injudicious allocation of the men after they have been secured.

We heartily support this latest announcement of the Premier, and trust he will not lose a single day in forcing the matter to its final conclusion. It will be a tremendous disappointment to the majority if he allows himself to be deterred and delayed by the opposition which is developing in certain quarters. We do not believe this opposition has any substantial basis in fact. However, if it has, so much the more reason for forcing the issue, that we may know who and where the enemies of the Empire are that we are falsely designating "citizens."

Time is the essence of the contract. Let us have conscription and have it quick. Necessity, justice, and loyalty alike demand it.

Conscription and Construction

CONSCRIPTION is to be put in force in Canada. Just what this means to our position and the position of our allies in the field of action is self-evident. At any rate, the enactment of a measure of compulsory war service is evidence of Canada's determination to see the end of the struggle she has voluntarily and of righteous cause entered upon. It is an indication to those who have suffered and borne the direst sacrifices that these sacrifices will not be in vain. Conscription involves, however, immeasurably more than a mere strengthening of our fighting resources. It is insolubly bound up in the industry and manufacture and all the other material elements of our country. These elements must be affected, bettered or, may be, harmed, by compulsory service action.

The foremost duty of all of us at this moment is to each give his mite of muscle or mind towards winning this war. All endeavors, national or individual, ought to be concentrated to this end. But this does not mean that we must let our normal status become disorganized. We must not forget that a disruption of our industrial equilibrium only serves to induce national hysteria. There are always alarmists who are only too ready to add to our troubles by condemning honest efforts to keep business running smoothly. They want us to assume a sack-cloth and ashes mood that implies a disorganization of business.

* * *

The correct attitude, as we see it and have frequently expressed it, is to keep business and industry operating, not necessarily "as usual," but in such measure as will meet the requirements of the time. The number of citizens employed to form a fighting force inappreciably reduces the total population which must still be fed, clothed, housed and employed. Business and industry are still called upon to supply the needs of a civil population, besides furnishing the requirements of the fighting forces. Even aside from this, the proper maintenance of home industry, exerts a tremendous moral influence by detracting our minds from the glooms, horrors and sacrifices of war. It stabilizes us, keeps us on our feeet, and encourages us.

The question, however, that now presents itself, is, "What influence will conscription have?" Whether conscription should, or should not, have been applied months ago can be thrashed out by the political hankerers. At least, this can be said, that the methods hitherto adopted to secure recruits have not been sufficiently discriminating. The desire to secure above everything else a volume of men has taken precedence over their proper selection. Numbers has been, to a large extent, the aim. Men essential to certain industries have been taken to the firing line to the detriment of these industries and the country itself. The woeful lack of suitable labor to carry on essential industries is a striking evidence of this. The experience of Canada is a repetition of Britain's earlier experience, but Britain was forced to make amends. After some months of war, it was found that the munition industries had been seriously impaired by the haphazard recruiting. Measures were taken to bring back thousands of skilled mechanics from the front and to replace them with those whose services were more valuable on the firing line. This impresses the fact that some men are more needed at home than in the ranks and that their services are worth more at their bench or in the workshop than in the trenches.

Although the details of the conscription bill are not laid down at this writing, there is in its inauguration a great chance of amending our past deficiencies. Conscription in its proper sense, means, not compelling men to go to the fighting line, but compelling them to serve their country. And much service may be as well performed at home as abroad. Each man's capabilities and opportunities must be considered. His special adaptations and training must be examined. These qualities ought to be given full play and, if found of service in industrial work, the man should, by all means, be kept in industrial work. If they are of service in the firing line, or back of the firing line, or in any other specialized branch of the service they should be made available in such occupations. The great fault of voluntary enlistment has been the taking of skilled or technical men, whose services are irreplaceable from positions that ought to be still kept intact.

Engineering and contracting work has suffered no less than other branches of industry. Just to what extent construction work is justified at the present time is open to opinion, because the question of finance is so involved. Our view has been that work of this kind, while being kept within reasonable bounds, must not be allowed to lag. An analysis of the situation shows the need of factories and offices as well as dwellings, in addition to civil engineering works. In Canada, there has been as yet no occasion to absolutely close down on construction work nor do we feel that there will be. However, the work of this kind that has been performed since the war has been severely handicapped by a lack of labor. Recruiting has withdrawn skilled men from their trades leaving at best a mediocre type of mechanic to fill the bill. The scarcity has been so great that imported help has had to be employed.

If a system of selective recruiting had been applied, no doubt suitable labor would have been available. Whether conscription will remedy the defects of the present method will have to be determined when the details of the scheme are made public. At least there is a wide opportunity for improved conditions, if compulsion is made truly selective. If so, engineering and contracting will be improved, industry and manufacture will be improved and the war will be improved. Indiscrimination in the selection of suitable soldiers will be avoided and the fighting and industrial armies will be placed on a truer relative basis.

The forestry unit raised by Major Marsh, Vancouver, has been turned into a railway construction corps and will be increased to 225 men.

The Progress of Water Filtration

STATISTICS recently prepared by Burrell & McDonnell, consulting engineers, Kansas City, Mo., show that there are now 781 water filtration plants in operation in the United States and Canada, as compared with only 50 in the year 1900. This total includes 443 municipally owned, 330 privately owned, and 8 plants owned by the U. S. Government. The accompanying table shows the distribution of these plants, of which the total filtration capacity exceeds 3,500,000,000 gals. The engineers point out that whereas a few years ago a bacterial removal of 96 per cent. was considered fairly good, anything less than 99 per cent. is now considered unsatisfactory.

As far as Canada is concerned, the figures are evidently inaccurate, as only five provinces are listed, with a total of 28 systems. No mention is made of British Columbia, Ontario or Nova Scotia. According to the last government report, Ontario has 27 filtration systems, Nova Scotia has 2, and British Columbia 2. Also Alberta has 10, as compared with 3 given in the table; Saskatchewan has 6, as compared with 4 given in the table; Manitoba has 5, compared with 3 in the table; Quebec has 19, as compared with 17 in the table. Recent installations would increase this discrepancy.

WATER-FILTRATION PLANTS IN THE UNITED STATES AND CANADA IN 1917

State or Province	—Ownership and Number— Municipal	Private	U. S.	Total	Population Covered	Total Capacity, Gals.
Alabama	6	5		11	250,000	27,025,000
Arizona		1		1	3,000	300,000
Arkansas	3	6		9	103,000	14,100,000
California	5	12	1	18	1,168,000	96,463,000
Dist. of Columbia	1	.		1	353,000	75,000,000
Colorado	6	3		9	271,000	62,475,000
Connecticut	3	3		6	175,000	31,000,000
Delaware	1			1	93,000	24,000,000
Florida	1			1	3,000	. .
Georgia	26	2		28	345,000	64,350,000
Iowa	11	10	. .	21	276,000	53,700,000
Indiana	5	14	...	19	553,000	92,950,000
Illinois	15	21	2	38	481,000	112,050,000
Kansas	29	4	1	34	218,000	42,726,000
Kentucky	7	11	...	18	379,000	108,750,000
Louisiana	3	1	...	4	406,000	52,500,000
Maine	2	8	...	10	86,000	22,550,080
Maryland	5	5	...	10	631,000	141,850,000
Massachusetts	10	2	...	12	368,000	44,800,000
Michigan	4	5	...	9	235,000	54,410,000
Minnesota	8	3		11	380,000	62,928,000
Missouri	16	15	...	31	1,021,000	203,432,000
Mississippi	4	1		5	83,000	14,300,000
Montana	6	..	...	6	35,000	22,800,000
New Jersey	13	19		32	339,000	165,194,000
New York	41	20	2	63	2,859,000	198,194,000
Nebraska	1	1	...	2	6,000	600,000
New Hampshire	2	4	...	6	51,000	6,614,000
New Mexico	2	1	...	3	6,000	1,500,000
North Dakota	6	...	...	6	42,000	8,836,000
North Carolina	32	7	1	40	315,000	47,455,000
Ohio	40	10	...	50	2,025,000	510,055,000
Oklahoma	28		.	28	266,000	45,720,000
Oregon	5	5	.	10	33,000	12,618,000
Pennsylvania	19	80		99	3,436,000	860,361,000
Rhode Island	1	9	...	10	316,000	33,000,000
South Carolina	9	6	...	15	172,000	27,400,000
South Dakota	1	2	...	3	24,000	1,850,000
Tennessee	5	3	...	8	125,000	23,500,000
Texas	16	3	...	19	378,000	42,130,000
Vermont	1	2	. .	3	30,000	4,570,000
Virginia	7	6	1	14	205,000	29,150,000
Washington	2			2	8,000	1,500,000
West Virginia	7	6	...	13	122,000	25,000,000
Wisconsin	6	5		11	176,000	38,950,000
Wyoming	3	1	.	4	12,000	6,115,000
Alberta, Can.	3	...	...	3	62,000	12,000,000
Manitoba, Can.	1	2	...	3	16,000	4,350,000
New Eruhswick, Can.	1	...	...	1	7,000	2,000,000
Saskatchewan, Can.	4	...	...	4	40,000	10,400,000
Quebec, Can.	10	7	...	17	539,000	166,250,000
Totals	443	330	8	781	19,545,000	3,659,771,000

The main point to be gathered from this compilation, however, is that tremendous advance has been made along the line of educating the people to expect and demand a higher standard of water supply.

Standard Bridge Designs for Ontario

Have Been Prepared by Provincial Highways Department as Suggestions to Counties and Townships of What Meets Government Requirements—Also Standard Culvert Plans—Revised General Specifications for Steel Bridges

IN a recent amendment to the Municipal Act of the Province of Ontario there are two clauses directly affecting highway bridge construction within the province. These are intended to provide a certain amount of government control over bridge structures erected by the municipalities. The section reads:

1. Every iron, steel, concrete, or stone bridge constructed by the corporation of a county, and every such bridge exceeding twenty feet clear span constructed by the corporation of a township shall be designed and built in accordance with general specifications approved by the Department of Public Highways.

2. Plans in duplicate for any such bridges may be submitted by the council of any county or township to the Department of Public Highways, and if they are found to be in accordance with such approved general specifications the certificate of the department shall be attached, and one of such plans shall be returned to the clerk of such county or township.

The general specifications referred to under (1) have been prepared for both concrete and steel bridges, and must be followed by counties and townships. The application of these specifications has just recently been extended to townships at the instance of the Ontario Good Roads Association. This action was brought about by two or three failures in steel bridges erected in townships and not over a few years old, the matter of design and specifications having been left entirely in the hands of the bridge companies. By requiring townships to adhere to provincial specifications uniformity is obtained with certainty as to the results.

Province Grants Financial Aid

The submission of plans for approval to the Department of Public Highways is purely optional, as indicated in (2) above. As a matter of fact, the county corporations take it upon themselves to submit all their plans voluntarily. This is because the province grants financial aid in the construction of permanent structures located on county roads belonging to a system of county roads assumed as such under the Highway Act. The county receives from the province a subsidy amounting to 40 per cent. of the cost of construction, and 20 per cent. of the cost of maintenance, and in this manner substantial encouragement is given to the construction of the best class of bridges and culverts.

The counties, by submitting their bridge plans for approval to the provincial authorities, although not compelled to do so, are taking no chance on having their subsidies withdrawn due to lack of adherence to the specifications as required. Townships not receiving the government assistance do not follow this practice to quite the same extent.

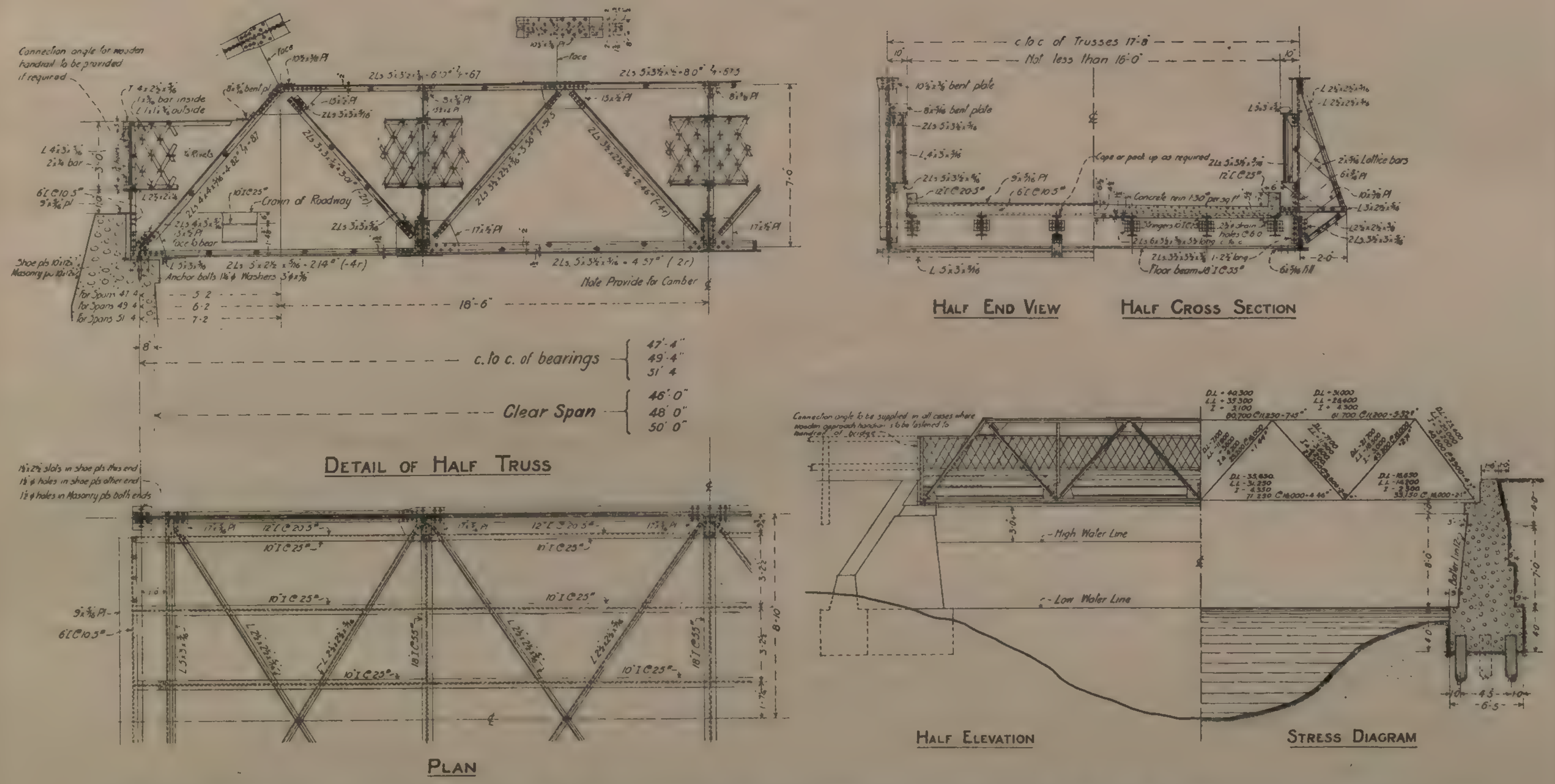
By these requirements the provincial Highway Department is kept in close touch with the construction of bridges by the local municipalities, and is assisting them to build permanent and substantial structures of a uniform quality throughout the province. To offer further assistance, the engineers of the Highways Department have prepared a series of standardized steel bridge plans with the intention of securing uniformity in this type of structure within the province. These plans are comprised in a book measuring 10 in. x 24 in. and containing 31 plates. Standard detailed designs are incorporated for steel bridges of all spans from 20 to 120 feet, with both 16 foot and 18 foot roadways. There are also detailed plans of culverts of various types, from 1 foot to 20 foot span. Standard abutments are also illustrated.

Standard Plans Secure Uniformity

These plans are not imposed on the county or township authorities, but have been drawn up as suggestions to the local municipalities as to what will meet the government's requirements. The accepted practice followed in letting bridge contracts has not altogether led to the best results. The usual plan has been to let the bridge companies prepare designs, stress sheets, and cost figures. The lowest tenderer is usually the successful bidder, but owing to the variance in designs, best results are not always achieved. The various designs may differ in their steel content by a great many tons. The provincial engineers in preparing standard plans are opening the way for a greater uniformity of practice. Counties that adopt these plans will receive tenders on a known basis for a known amount of steel erected in a predetermined manner. There is thus no chance, under competent inspection, of having less steel than a bridge of the desired capacity needs. Moreover, it is certain that a bridge b to these designs will be open to receive a provincial grant towards its construction and maintenance.

Provision for a 15-ton Live Load

The plans are drawn for spans varying by 2 feet up to 90 feet. Above that the spans are 100 and 120 feet. The loading is in all cases known as class "A," which provides for a 15-ton road roller. A bridge of this type is suitable for main travelled or county roads, and is recommended as the standard on all roads. The types of bridges indicated in the standard plans are rolled beams for spans up to 40 feet, pony Warren truss for spans of from 40 to 90 feet and the through Pratt truss for the longer spans from 100 to 120 feet. These designs are prepared in accordance with the 1917 specifications for steel highway bridges as issued by the department. All the bridges are designed to carry a dead load composed of the weight of the bridge; also a concrete floor 6½ inches in thickness in the centre and 5½ inches in thickness at the sides, and a live load composed of a 15-ton road roller. End floor beams are recommended for all truss bridges. They stiffen the trusses considerably, and the cost of such floor beams is very little, if any, in excess of the cost of forms, labor, and concrete for a joint wall. A detail consisting of a cover plate to prevent debris falling between the gusset plates, as shown in the series of plans, is also recommended. For T-chord bridges it is advisable to place a cover 5/16 inch thick on the end post, to prevent the rapid rusting away of the steel, which



Standard plans have been prepared by the Ontario Department of Public Highways for steel bridges of 20 to 120 ft. spans, with 16 ft. and 18 ft. roadways. This cut illustrates the design for clear spans of 46, 48 and 50 ft. and 16 ft. roadway. The following are the assumptions: Dead load—Concrete, 1,275 pounds per lineal foot; steel, 440 pounds per lineal foot; total, 1,715 pounds per lineal foot. Live load—Uniform, 1,500 pounds per lineal foot; concentrated, 15 tons on two axles, 6 ft. gauge, 10 ft. centres, two-thirds load on rear axles.

occurs sometimes at or about the floor level. Stringers are attached to floor beams by means of lug angles, as such a connection provides a rigid and strong detail, adding very little to the cost of the bridge. The use of such a detail is fully justified by experience.

Details May Be Altered

In each plan are indicated the stresses, details of members and connections, with details of reinforced concrete abutments. Of course, these designs are subject to change as far as detail is concerned. For example, the handrailing, shown in every instance as latticed steel, may be altered without impairing design. The plans are only to provide suggestions, but they fill a want, as indicated by the avidity with which townships and counties are using them.

As also indicated above, standard culvert designs have also been prepared which will meet with the requirements of the department. Another useful feature incorporated in the plans is a table showing the size of structure to be provided to drain any number of acres up to two thousand. It is not intended that the sizes of structures therein given are absolute and unchangeable, since the size of opening required for a bridge or culvert depends on a number of conditions. The figures given in the table are intended only as an aid to judgment, and care should be used in their application. The proper size of waterway to provide for any particular location may be obtained by measuring other satisfactory openings on the same stream or by determining the area required to pass the usual flood conditions on the watercourse, making allowance at the same time for extraordinary conditions, such as ice and driftwood. The testimony of local residents is always of utmost value regarding high-water level, and, if possible, the evidence of at least three such people regarding flood conditions at the site should be secured. An ample margin of safety is always to be allowed, and in the case of steel bridges this is usually obtained by placing the lower chord of the bridge from one to three feet above the highest observed water level. In deciding the proper span of bridge to build at any location consideration must be given to a number of conditions, such as the width of the river during ordinary flow and at times of flood, the nature of the bottom and bank, the height of high water, the manner in which the ice and driftwood passes the site of the bridge, and the alignment of the channel of the river above and below the bridge. In this connection the width of the river, from bank to bank, should be given full attention. The river has been able to carry away everything between its banks, and it is well to respect this power which water possesses.

As typical of the designs that have been prepared, we are reproducing herewith the general plans for a steel highway bridge, having clear spans of 46, 48, and 50 feet, with a 16 foot roadway.

Similar Designs for Concrete

Similar standard designs are being prepared for concrete bridges. Certain difficulties are attached to the evolution of standard designs since local conditions play a considerable part in the construction of such bridges. The Provincial Highways Department, however, is incorporating in its plans designs of concrete beam bridges of from 20 to 40 foot spans, complying with the 1917 concrete bridge specifications of the department. When this series is completed there will be available for the use of county and township authorities designs of almost any type and size of bridge or culvert that will strictly adhere to the requirements and will be uniform throughout the province.

The department is urging the construction of wide structures, 20 feet, if possible, and at least 18 feet. The economy of a roadway of 16 feet or less in width is not comparable with the increased safety of wider bridges. In long spans, where the steel becomes expensive, a 16 or 18 foot roadway is recommended, but the shorter spans can quite well be provided with an 18 or 20 foot roadway without adding greatly to the cost.

Reference was made above to specifications for both concrete and steel bridges to which county and township authorities are required to comply. In the Contract Record of February 7, 1917, those covering concrete bridges were outlined. In the following paragraphs the general specifications for steel bridges are abstracted:

Types of Bridge

The general type of girders and trusses, unless specifically stated, may be determined by the bidder, but shall preferably be:

(1) Rolled beams for spans up to 40 feet.

(2) Riveted low trusses or girders for spans of 40 feet to 90 feet.

(3) Riveted through trusses for spans of 90 ft. to 250 ft.

(4) Pin-connected or riveted trusses for spans of 250 feet and upwards. On through spans of 120 feet and upwards, a curved top chord is preferred.

(5) Deck spans shall be used wherever practicable.

(6) Warren trusses will be favorably considered for spans of 40 feet to 90 feet; Pratt trusses for spans of 100 to 250 feet, and Petit trusses for bridges 250 feet in length and upwards.

General Dimensions

In all cases, from the top of the floor to the under side of the portal bracing of through bridges, there shall be a minimum head-room of 14 feet. The clear width of the sidewalk should not be less than 6 feet and the clear width of roadway shall preferably be not less than 16 feet, but may be 14 feet for country bridges not on main highways.

Loading

Bridges will be classified according to loading as follows:

Class (A) Bridges suitable for main travelled or country roads.

Class (B) Bridges suitable for roads of light rural traffic and for less permanent requirements.

Class (C) Bridges suitable for heavy traffic on main highways in the vicinity of towns and cities.

Assumed Weights of Materials

Treated or untreated timber shall be assumed to weigh 4½ pounds per foot board measure; sand, gravel or other material used as filling, 100 pounds per cubic foot; paving brick 150 pounds per cubic foot; concrete 150 pounds per cubic foot; steel 490 pounds per cubic foot.

Allowable Unit Stresses

All parts of the structure shall be so proportioned that the following unit stresses in pounds per square inch shall not be exceeded:

(1) Axial tension on net section 16,000
(2) Axial compression on gross section ... ... 16,000 – 70 l/r
In which "l" is the length of member in inches, and "r" is the least radius of gyration in inches.
(3) Direct compression on steel castings ... 16,000
(4) Bending on extreme fibres of rolled shapes, built sections, girders and steel castings (net section) 16,000
Extreme fibres of pins 24,000
(5) Shearing:
Shop-driven rivets, 10,000; field-driven rivets, 8,000, plate girder webs (gross section), 10,000, pins 12,000
(6) Bearing
Shop-driven rivets, 20,000; field-driven rivets, 16,000; pins, 24,000
(7) Steel expansion rollers, per linear inch ... 600d
In which "d" is the diameter in inches.

Timber

The allowable working stresses in bending on the extreme fibres of timber shall be as follows, all stresses being given in pounds per square inch. Douglas fir or long leaf southern yellow pine, 1,800; white oak, 1,600; red or white pine, 1,200; white spruce, 1,000; tamarac, 1,000; hemlock, 800.

Masonry

Bearing under bed plates, in pounds per square inch, shall be as follows: Stone or gravel concrete, 500; granite masonry, best ashlar, 500; sandstone or limestone masonry, best ashlar, 400.

Impact

A change in the allowance for impact is made in the 1917 specifications. Previously it was to be calculated by an involved formula, but allowance is now to be made on a percentage basis. This revision is allowed because of the impossibility of accurately determining impact stresses. Experience has indicated the reliability of the percentages indicated. The specification reads:—

Impact shall be added to the maximum computed live load stresses. For stringers, floor beams and hangers the impact shall be 30 per cent. of the maximum computed live load stress and for all other members, except as noted below, the impact to be added shall be 10 per cent. of the maximum computed live load stress. Impact shall not be added to stresses produced by lateral or wind forces. For counters and members having alternate live load stresses of tension and compression the impact to be added shall be 50 per cent. of the greater live load stress.

Standard Practice Followed

The clauses covering general design and construction follow current practice with few changes from the previous edition of specifications (1911). A minor alteration in the minimum thickness clause is made, which makes it possible to require a ⅜ inch minimum in larger structures. This is to ensure greater durability, and even where smaller plates would be of sufficient strength, a ⅜ inch minimum provides more uniform sections with more even wear. The specification reads:—

The minimum thickness of material shall be 5/16 inch except lattice bars and fillers. Where specifically required by the engineer the minimum thickness for large and important structures shall be ⅜ inch. The webs of channels may be of thickness approved by the engineer, but minimum weights per foot shall be: For 5-inch channels, 9 pounds; 6-inch channels, 10½ pounds; 7-inch channels, 12¼ pounds; 8-inch channels, 13¾ pounds; 9-inch channels, 15 pounds; 10-inch channels, 20 pounds; 12-inch channels, 20½ pounds; 15-inch channels, 33 pounds. The minimum angle shall be 2½ in. x 2½ in. x 5/16 in., or 3 in. x 2 in. x 5/16 in., except the bottom angles of hand-rails, which may be 2½ in. x 2 in. x ¼ in. No I-beam smaller than 9 inches shall be used except for Class B bridges or where expressly permitted by the engineer.

Power Driven Rivets

In connection with the riveting, power driving is now to be used whenever possible. It is felt that the purchase of a compressor will involve no hardships to the counties, besides which its use is not limited to pneumatic riveting.

The specification for rolled I-beams spans reads:—

Rolled I-beams shall have a depth of not less than 1/20 of the span. Outside girders of rolled beam spans shall have sole-plates riveted to the flanges and bolted through bed plates to the masonry at one end and free to slide longitudinally at the other. Girder spans shall have rigid cross struts at their ends. Beam spans shall have rigid cross struts at their ends and also at the centre.

Paint

Although three coats of linseed oil and red lead are regarded as the most satisfactory paint for steel bridges, provision if made, owing to the present high cost of materials, for a base coat of this type of paint with subsequent coats of an accepted proprietary paint.

Hand Railing

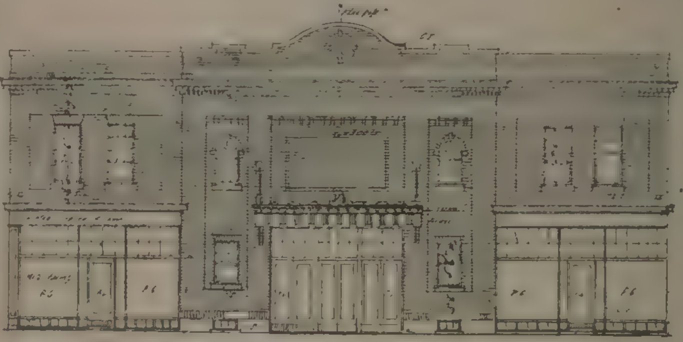
Hand railings are required to be not less than 4 ft. in height, of galvanized iron pipe or steel lattice. Portions extending beyond the steel superstructure are to be provided with iron or steel posts and bedded in concrete. The top flange of the railing is to be designed to withstand a transverse, horizontal thrust of at least 60 lbs. per lineal foot.

Floors

The designs of the Provincial Highway Department, referred to above, in all cases make provision for concrete floors since these are regarded as the most durable and satisfactory. The specifications, however, allow timber, but it is felt that concrete will prove cheaper in the end. Standard practice is adopted in the laying of timber flooring. Owing to the extreme fire hazard of creosoted wood block paving, the specification stipulates that the block be laid on reinforced concrete foundation protecting all steel work with a covering of not less than 2 inches. The joints that are to be used comprise sand in the lower one-third, tar in the centre, and sand on top.

New Theatre at Montreal

Mr. D. J. CRIGHTON, architect, has drawn plans for a moving picture house for the Majestic Theatre Company, the contract for which has been let to J. Gilletz & Co., Montreal. The building is to be erected at the corner of Sherbrooke Street and Grey Avenue, Notre Dame de Grace, a suburb of Montreal, on a site 90 x 114 feet. It will provide accommodation for 1,200 persons, and will consist entirely of an auditorium without galleries. Four exits are shown on the plans, two at the front and two at the rear.



Sketch of front elevation of theatre at Montreal.

The main entrance, on Sherbrooke Street, will be flanked on either side by a store. The foundations will be of reinforced concrete, and the exterior of plastic brick, with a scheme of panels and ornamentation in different shaded brick on the Sherbrooke Street frontage and on the Grey Avenue side. The cornices will consist of galvanized iron, finished in a copper color. Light will be provided by means of eight windows, two on each side and four in the centre.

There are to be two vestibules, the ticket office being located in the inner one. The walls here will be lined with Missisquoi marble and the flooring of tiles. On the right side of the second lobby will be situated the office of the cashier and the general offices, while on the other side there will be a ladies' waiting-room; the floors in this section will be of terrazo. A stairway leads on the right side to the operator's room and also to a basement, where provision is made for lavatories, furnace room, space for ventilating plant, and stores. This basement runs under the front portion of the building.

The auditorium is reached through doors from the inner vestibule. It will consist of a parabolic floor, divided into four aisles, with three banks of seats. The flooring will be of concrete, except in the aisleways, where it will be of terrazo. The stage is to be 10 feet deep, with accommodation for the orchestra on the stage level. At either side there is an opening from the back of the stage to permit the entrance of performers. Musicians' and other rooms are provided at the rear of the stage. The frame of the screen is to be of plaster, elaborately decorated with moulded ornaments.

The interior walls and the ceiling will be of plaster on wired lath. The scheme of decoration for the former provides for the walls to be divided up by pilasters, with ornamental cartouches. The pilasters divide the walls into panels, which will be surmounted by a decorative band. At the head of the pilasters decorated cornices will be carried around the hall. Above the cornices there is a large cove for the indirect electric lighting. Around the ceiling, at the intersection with the cove, will be placed an ornamental band. Five openings, decorated in plaster, will be made in the ceiling for ventilation purposes, while a suction fan for exhausting the air will be located on the roof.

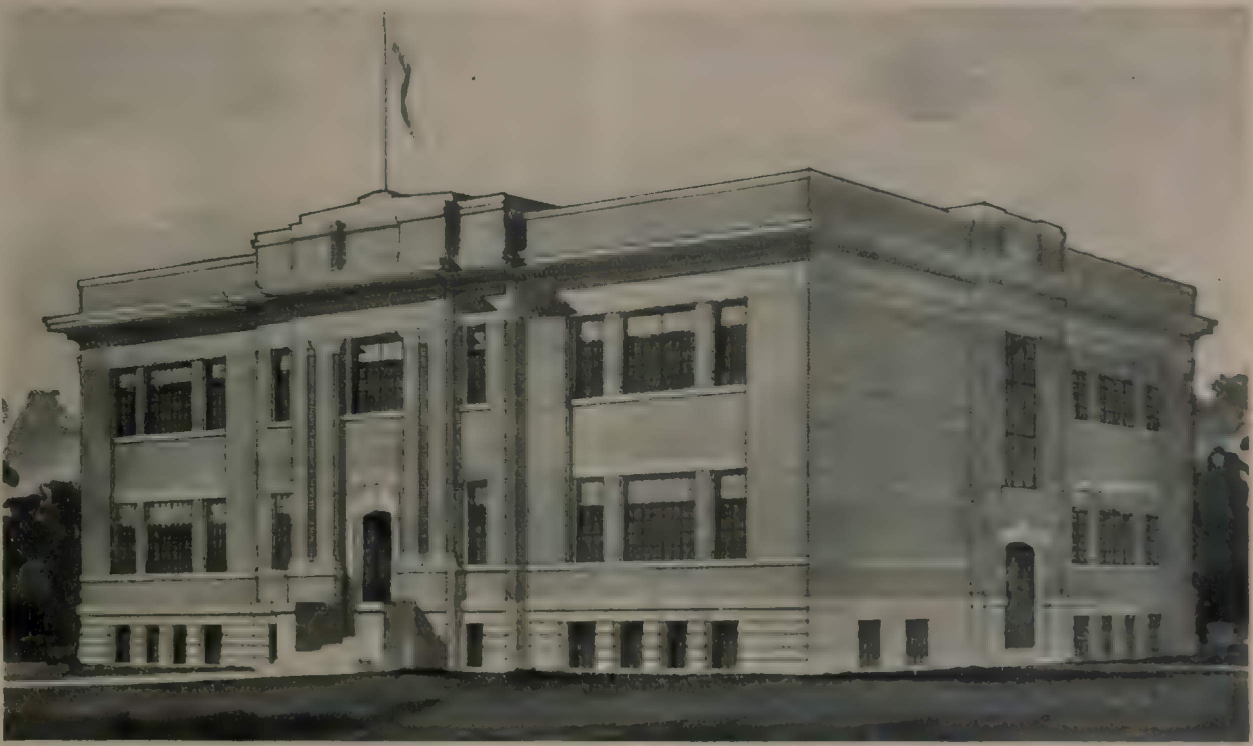
In the main, the lighting will be by means of 25 watt lamps, the wiring being encased in galvanized iron conduits. D. and W. fuses are specified. An outside sign will be erected, provided with 350 lights. Two panel boards are to be installed, one on the ground floor and the other in the operators' box, for controlling all internal and external lighting.

Trenton Collegiate

WE reproduce herewith a perspective of a new collegiate institute for the town of Trenton, Ont., upon which work has just been commencedd. It will be a two-storey and basement [illegible] of the hollow tile type of construction, faced with [illegible] on pressed brick. Concrete foundations are being laid. The exterior trimmings will be of Indiana sandstone and Queenston limestone, and there will be a galvanized iron cornice around the building.

The site of the school is favorably located on the east side of the River Trent, in the residential section of the town. The main entrance is on the west side of the building, and on the north and south, entrances are also provided. The plans call for a structure 75 ft. in width by 112 ft. in length, with all class rooms of standard size, 24 ft. x 32 ft. On the ground floor there will be three standard class rooms, principal's room, lavatories and an assembly hall. A corridor 12 ft. wide runs through the centre of the building connecting the entrances on the north and south. The assembly room, in the northeast corner of the structure, is 32 ft. long by 64 ft. wide, with a seating capacity of 450. The remaining three corners of the first floor are occupied by class rooms. The entrances lead into open vestibules and through enclosed vestibules to the corridors. On the second floor there will be four class rooms, physical and chemical laboratories, lavatory, library, teachers' room, and girls' wardrobe; also a store room and dark room in connection with the laboratories. The basement will contain a gym-

(Continued on page 509)



New Collegiate Institute for Trenton S. B. Coon & Son, Toronto, Architects

Compensation for Submitting Tenders

Standard Bidding Practice for Contractors, Whereby Present Competitive System is Made More Equitable and Its Defects Remedied

MR. H. W. NELSON, of Moline, Ill., recently presented a paper before a convention of the National Association of Builders' Exchanges, in which he outlines a plan by which contractors shall be compensated for submitting bids on any work. He estimates that the cost of building is increased on the average not less than 4 per cent. by the present system of competitive bidding, in connection with which there is so much unnecessary waste. In detail, Mr. Nelson's plan is as follows:

My form is based upon the following principles underlying competition: Estimating costs and establishing prices is an overhead expense involved in any merchandising, but the cost of doing so is generally nominal, if not insignificant, and the cost can be justifiably distributed. The cost of figuring or estimating work in accordance with special plans and specifications to meet each case, however, differs materially from establishing a price on each of a thousand hats, all made from the same material and from the same pattern. Therefore, my form is suggested to meet special conditions; to more justly distribute the cost of competition and estimating, and to make each building bear its own proportion of the cost. My form is submitted with the thought that there are three main factors entering into the relations between the purchaser and the seller, viz.:

1. Quantity and quality of materials.
2. Character of labor and personal service.
3. Price to be paid for both.

The first factor—quantity and quality of materials—can be determined and definitely set forth in the form of plans and specifications, upon which the bidder can base his price. The second—labor and personal service to be rendered by the bidder or expected by the buyer—varies as much as human nature varies, and cannot be so definitely or exactly set forth. The price—or third factor—can be based definitely upon the materials, but must necessarily vary upon the personal service, depending upon the value placed upon it by either the bidder or the buyer.

To Purchase Competition

Therefore, when the buyer desires competition to enable him to make comparisons or decisions, based upon a combination of all three factors, competition which involves labor and expense on the part of the bidder, then the buyer shall purchase that competition at a fair and just price, just as he purchases anything else.

The buyer alone derives the benefit of competition, and no one buyer should pay for competition received by another—an abuse that exists under present methods. When and after the buyer has chosen his competition in a fair, unprejudiced manner, and has further paid a just and reasonable price for said competition, he shall be under no moral or other obligation to the bidders. He may make his own decision, based upon his own opinion of the qualifications of the bidder or the bidder's price, or a comparison of both. A contractor should in no way be considered as an engineer, but solely in the light of a bidder and contractor capable of doing work in accordance with complete plans and specifications; and, therefore, in every case where bidders are expected to bid in competition they should be furnished with definite plans and specifications, covering the work to be performed as completely and specifically as commercially possible.

Contractor Not an Engineer

If a buyer cannot and will not provide complete detailed plans and specifications for the work, but wants estimates, measurements, figures, or advice of a professional nature, then he (the buyer) shall consider such work in the light of a professional service, and it shall not be considered proper, fair, or just to ask for competitive price bids, but the charges for such professional service should be left for adjustment between the buyer and seller, either before or after the work is done. Approximate estimates should not be considered binding upon either party involved. Now, my idea is this: Whenever a man asks you to give him a figure on his work you should ask him if he wants a competitive figure. If he tells you he does, you should request from him a set of complete plans and specifications. If he has none you should send him to your architect or engineer.

You must make up your minds to be either one thing or the other. Either engineers or contractors. If your customer then gives you a set of plans and specifications and wants a competitive figure from you, tell him that you will be glad to give it to him provided he pays you for the time, money, and talent required to give it to him, not otherwise. Now you ask: How much shall I charge him? Of course, strictly speaking, that is up to you. You ought to know. But in order to standardize and make a start I have suggested a method. It is recognized that the cost of figuring is in proportion to the size of the job. That is the first factor. In fact, the percentage of cost of figuring reduces almost in exact proportion as the size of the job increases. The only mathematical way I know of to arrive at it correctly is to work it out by taking the square root of the amount of the contract.

Now, if you choose any factor or number to multiply this square root number by, you will find that the percentage of your charge will be reduced automatically as the size of the job increases. You can set these factors yourselves. The electrical contractors can use 30 per cent. of the square root; the plumbing contractors 20 per cent., etc. You can establish one definite factor for each branch for universal use throughout the country, and then you are done. Or, if your local exchanges are mixed, and its members are composed of all crafts, then you can adopt co-operative working arrangements, such as was done by the Quad City Builders' Exchange.

Plan Already in Operation

I did not perfect the form until last April, after thinking it over and working on it for years. Since last April until now I have been working with the Quad City Builders' Exchange to perfect their working arrangement, and I cannot say that we have yet finished. Yet, I understand that many contractors in our community are being paid for their bids. In fact, I absolutely know that some of them are. I don't expect that all of them are or ever will. But those who are being paid for their service need not worry about those who are not being paid.

But if you contractors established a new trade custom of this kind, which, it cannot be denied, is fair and equitable to all, you would accomplish many things. If owners had to pay for competition they would reduce it to a reasonable basis. They would base their decisions on other factors as well as price. They would see to it that their architects and engineers made careful and conservative estimates, so as to avoid paying for competition twice or three times. If they had to pay in proportion to the amount of work done by bidders in estimating they would see that their engineers prepared specific plans. It would elevate the character of engineering service and help the real architect. It would make each owner pay for just the competition he received and not compel him to pay for competition received by others. There are so many things it would do to better conditions that I could not begin to mention them all.

Competition Adds 4 Per Cent. to Cost

Last year $2,000,000,000 was spent in erecting buildings in this country. It cost the contractors of this country $80,000,000 to furnish competition. Millions of dollars can be saved by you contractors if you will adopt better methods. A large portion of this waste is not only lost to the contractors, but is an economic waste, which the consumer pays. The public is the loser because of your present methods. The ultimate consumer pays the bill. He will welcome any change in your methods that will save him an unnecessary expense, lower the cost of building work, and better the character of your work and your service to him. At first he is liable not to understand, but you will have to educate him. It is your duty, both to him and to yourselves. It is for the good of the ultimate consumer, the public, also for your good, that I ask you to change your standards of practice, your trade custom.

War Opens Up New Trade Opportunities

Data Collected by Dominion Government Emphasize Value of South Africa as a Market for Canadian Commodities

CANADIAN manufacturers are naturally eager to learn of trade opportunities which may be initiated during the war, with a view to development as soon as hostilities cease and the transportation routes are restored. In this connection the annual review of the work of the Canadian Commercial Intelligence Service, just issued by the Department of Trade and Commerce at Ottawa as a supplement to their weekly bulletin, will be of special value. This report reviews the work of the Intelligence Service for the year 1916.

As typical of the kind of information being gathered for commercial purposes, we print below part of the report on the South African market. This appears to be capable of tremendous development if the matter is attended to immediately, and while Germany and her allies are eliminated as trade competitors:

Value of the South African Market

The purchasing power of South Africa in proportion to its population is very high. South Africa has made considerable headway during the past two years in enlarging old, and establishing new industries, but owing to new developments in mining, manufacturing, irrigation, cattle raising, and agriculture, importation will continue on a large scale for years, and as most South African importers are determined to purchase as much as possible of their North American requirements from Canada, Canadian manufacturers and producers of all kinds should realize the necessity to supply every information possible regarding their position for immediate export and the possibilities for export in the near future, as well as immediately after the war.

The iron and steel trade and manufactures thereof, including engineering, mining machinery, mining supplies, railway material, and agricultural machinery firms have an opportunity to establish a trade which will not be duplicated for a long while in any field of export. This applies to many other lines which will be dealt with in detail further on in this report.

The import trade this year for the nine months ending September 30th, is a little better than the previously best year for imports into South Africa, the year 1913, when the imports reached a value of $201,700,000, and although at the moment it is impossible to secure figures showing quantities imported this year, there is no doubt that the quantities in many lines are much less, the values being higher, which is balanced by the fact that exports from South Africa are being sold at a much higher price than any time in the past. Thus, the year 1916 has been a prosperous and progressive year for South Africa.

So that Canadian firms interested in export may realize the value of this market and the necessity for representation in a field which is eager to purchase Canadian goods, the following table has been arranged showing the average annual imports for the past five years into British South Africa, on articles for which Canada should secure a larger trade.

Value of Average Annual Imports

Agricultural implements of all kinds	$1,900,000
Agricultural machinery	850,000
Food and drink, articles of—	
Flour and meal	3,000,000
Grain (including malt)	4,600,000
Fruit, fresh (including nuts)	325,000
Fruit, dried or preserved	390,000
Vegetables, preserved	185,000
Butter and butter substitutes	**1,250,000**
Cheese	790,000
Milk, condensed	2,125,000
Hams, bacon and salted meats	1,150,000
Meats, preserved	700,000
Biscuits	345,000
Confectionery, jams and jellies	1,475,000
Fish, fresh, dried or preserved	1,275,000
Raw material	
Brass and copper	875,000
Iron and steel	4,300,000
Tar, bitumen and asphalt	132,000

Glycerine for manufactures	2,300,000
Leather, unmanufactured	970,000
Wood, raw and partly prepared	3,900,000
Brushware	280,000
Clocks and watches	390,000
Furniture of all sorts, including carpets	2,825,000
Glass and glassware	1,050,000
Lampware	225,000
Plate and Plateware	610,000
Antifriction grease	230,000
Electrical machinery	2,020,000
Fire engines	72,000
Manufacturing and sawing machinery	1,460,000
Mining machinery	4,310,000
Printing machinery	190,000
Water-boring machinery	97,000
All other (and parts thereof, not including locomotives or agricultural machinery)	4,400,000
Metal manufactures other than machinery—	
Brass and copperware	186,000
Fencing material, wire standards, etc.	2,030,000
Tar manufactures	192,000
Hardware and cutlery and iron manufactures	7,375,000
Paints and painters' goods	950,000
Soap of all kinds	544,000
Textile goods, wearing apparel, etc.—	
Apparel and slops or clothing	12,500,000
Boots and shoes	5,750,000
Canvas and duck	272,000
Cotton piece goods	8,460,000
Cotton manufactures (N.O.D.)	7,340,000
Hats and caps	1,125,000
Tents and tarpaulins	240,000
Woollen piece goods	1,550,000
Woollen manufactures	2,320,000
Miscellaneous manufactured goods—	
Arms and ammunition	1,247,000
Binder twine	92,000
Cordage and rope	235,000
Drugs, chemicals and medicines	4,950,000
Electric cable and fittings	2,200,000
India rubber goods (not tires)	212,000
Instruments, musical	700,000
Instruments (N.O.D.)	154,000
Jewellery	692,000
Leather manufactured (Not B. & S.)	512,000
Paper of all sorts	1,600,000
Perfumery	410,000
Printers' materials	226,000
Railway and tramway materials (including locomotives but not S.A.)	2,350,000
Saddlery and harness	265,000
Sporting goods, toys and tobacconists' wares	1,240,000
Stationery and stationers' goods of all sorts	3,585,000
Tires	1,500,000
Vehicles of all sorts, not motor	1,370,000
Vehicles, motor of all sorts	4,300,000
Wood manufactures (not furniture)	1,175,000
South African Government purchases	14,770,000
Total average annual imports	177,000,000
From United States of America	17,000,000
From Canada	4,000,000

Prospects for 1917

The figures of trade in South Africa for 1916 show prosperity all the way through; in fact, at the moment of writing the returns show a better trade for a given period than the trade of 1913, which was high-water mark for South Africa. All signs indicate a continuation of the 1916 prosperity if not an increase of same, as all mineral and agricultural productions of the country are in greater demand at higher prices.

Gold mining is still working at high pressure, and will continue its special efforts of production. New areas have just been leased to strong mining corporations by the South African Government; this means immediate development and, in consequence, a large demand for new mining machinery and supplies. The diamond mining is resuming operations on an extensive scale, and the results of the 1916 sales are away beyond all estimates, with every prospect of the demand continuing.

The ocean freight rates are certainly helping to restrict imports on certain lines, but in a general way on most of the lines which Canada is in a position to offer South Africa, there is sure to be a demand which should mean good business for Canada in 1917, with her increased representation, if the local conditions governing the production at Canadian plants will permit the manufacturer to cater for the export trade. In connection with this phase of the position, it may be a hard thing to accomplish and it may have to be done at some extra cost, but it is safe to say that the Canadian firms who make a real effort for this market in 1917 are assured of a permanent trade in the future.

U. S. Government Erecting Thirty-Two Cities for Its Armies

PLANS have been made and locations are now being selected for the 32 towns to be erected by the United States Government for mobilization camps for the new army of 1,000,000 men. Each camp will be of sufficient size to provide for about 22,000 soldiers, and will be a complete city in itself. As soon as the camp sites are chosen the surveys will be made and contracts will be let. The construction work will be done by contract, under the supervision of army officers.

To direct this undertaking Col. I. W. Littell, of the Quartermaster-General's Division, Washington, D.C., has been placed, by order of the Secretary of War, in general charge of cantonment construction. Col. Littell has already begun organizing his forces for the work.

It is estimated that 600,000,000 feet of lumber will be required, and arrangements are being made to secure this in all parts of the country, preferably in the section where the camps will be located. Each of the 32 cantonments contain about 2,000 houses. These will include quarters for the men, officers' quarters, kitchens, mess halls, bathhouses, storehouses, and all the various buildings needed for housing the troops and providing for the varied activities of a big camp. Most of the buildings will be long, one-storey structures, with some two-storey houses. They will be of plain construction, but will be of modern type, and the plans and sanitary arrangements will carry out the most approved methods. They are expected to be the best arranged, cleanest, and most up-to-date barracks yet erected.

Each town will cover about 720 acres, a little over a square mile, and this does not include the large area required for drill grounds at each camp.

The contractors who are to do the construction work will organize their own forces of carpenters, laborers, etc., but the building will be done under the direction of army officers. Several officers from the quartermaster's department, government inspectors, timekeepers, foremen, engineers, plumbers, etc., will be stationed at each camp town, and Col. Littell has already begun to arrange for the men required for this work.

In addition to the 32 camp towns, the quartermaster's department will erect groups of warehouses at points where army stores are to be concentrated. The exact number and location of these has not yet been determined, as they are to be erected to meet the needs of the army as they arise.

Patricia Bay Ferry Slip

Part of C. N. Ry., Vancouver Island Service —Further Improvements to be Completed this Year

THROUGH the kindness of Mr. D. O. Lewis, district engineer for the Canadian Northern Railway at Victoria, the Contract Record presents below an illustrated description of the new Patricia Bay ferry slip, 15.2 miles from Victoria, which forms the connecting link between the Vancouver Island lines of the C.N.R. system and the Mainland terminals at Port Mann and Vancouver. At the latter point the handsome new station building, freight sheds, roundhouse, and other structures are being rushed to completion, while work on the new terminal buildings on the Songhees Reserve, Victoria, is also being pushed with all possible speed. The end of the present year will probably see all improvements completed and the coast-to-coast service of the company fully installed.

Patricia Bay Ferry Slip

It may be well to explain that the photographs shown were taken some weeks ago, when the slip was nearing completion, but the views give a very good idea of the general appearance of the completed structure.

Figs. Nos. 1 and 2 show the berth in which the transfer ferry will lie when coupled to the slip. The 6 in. planking is spiked on heavy wales, attached to the piles, the darker colored portion being creosoted timber—in fact, all the material used in this structure was creosoted, with the exception of the light-colored face planking of the fenders, as shown. The fenders consist of five rows of piles braced parallel so that the piles act as spring piles in unison. On top of these fenders there is a fenced walk, with mooring piles at short intervals for mooring the transfer slip. At each end of the wings of the fenders there is a dolphin of thirty piles, held together at the top by ⅝ in. steel cable, but unattached.

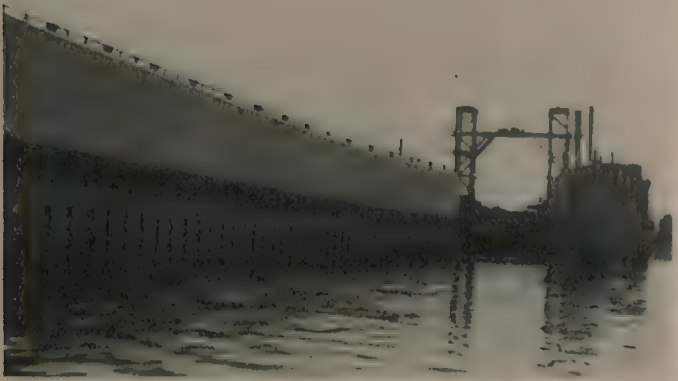


Fig. 1—Patricia Bay Slip for C. N. Railway, Vancouver Island.

There may also be noted the uncompleted gantry, on which will be placed the raising and lowering mechanism for the front end of the slip. Fig. 3 shows a view of the transfer slip proper, which is so surrounded by sidewalks that the steel girders are not to be seen.

The berth has been constructed to permit the mooring of the 308 foot ferry, but smaller barges which are now in use can be operated also in the same berth.

The transfer apron is in three parts, each 36 feet in length, and consists of steel girders, the shore end being hinged on cast shoes, having a foundation of creosoted piling. The two middle hinges are supported by cross girders, and are raised and lowered by screw mechanism. The outer end is raised and lowered by machinery and counter-weights situated on the gantry. The motor power for raising and lowering the apron will be electricity.

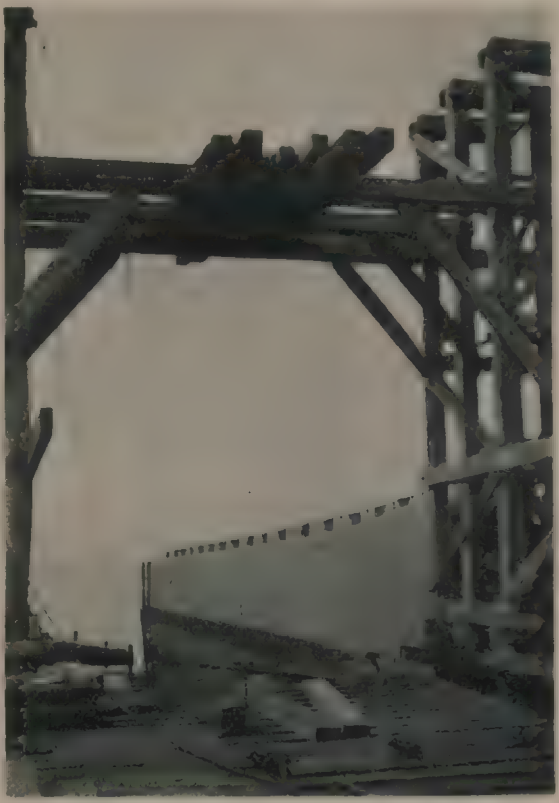


Fig. 2—Patricia Bay Slip, Vancouver Island.

This transfer apron, 108 feet in length, can be raised and lowered so as to accommodate any stages of tide having a difference of 14 ft. 6 in., which, as far as ascertained during the past three years, is the limit of dif-

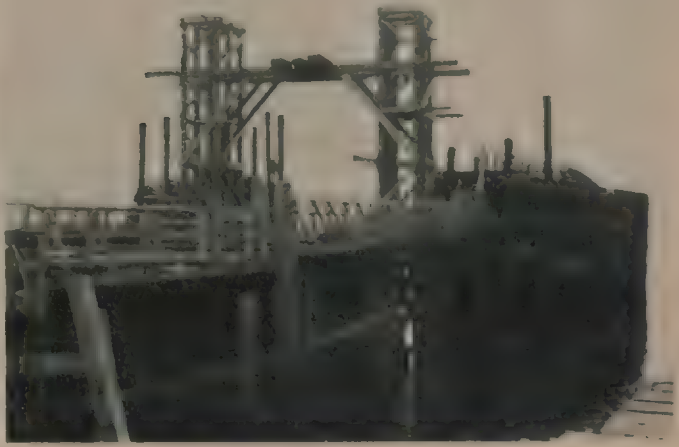


Fig. 3 Transfer Slip, Patricia Bay C. N. Railway

ference between extreme high and low water at Patricia Bay.

The transfer ferry, which is now under construction at Point Levis, Quebec, and ferry apron and mechanism, were designed by Mr. A. Angstrom, marine architect, Toronto.

Handling Stucco To Get Good Results

At a meeting of the American Concrete Institute, Mr. J. B. Orr presented a paper on "Artistic Stucco," in which the history and development of this building material were outlined with indications of the proper manner of applying it. The author drew attention to the great possibilities of stucco, which have, for many reasons, been scarcely recognized. He gives the results of his practical experience and offers suggestions as to the proper methods of handling stucco with the greatest benefit. The specifications recommended by Mr. Orr follow:—

Preparation of Surface—The entire surface is examined and all loose form scale removed from the surface, i.e., the scale is caused by cement adhering to forms from previous pours. (When the form is not entirely filled in one day's operations, a film of cement adheres to the form in places and sets when the pour is made. This film invariably forms a scale surface on the face of the concrete when the forms are removed). The entire surface is gone over with a hand pick or an axe to roughen the surface; if brick, rake out joints. This is for the purpose of forming key for stucco. The surface to be brushed clean and thoroughly soaked, ready for application of stucco.

Proportions: Straightening Cost—The proportions of this coat shall consist of four parts of Portland cement of approved brand to 12 parts of sand and two parts of hydrated lime. The above material to be thoroughly mixed dry, then tempered with water, to which has been added three parts of concentrated waterproofing paste to every 25 parts of water.

Finish Coat—The proportions of this coat shall consist of five parts of Portland cement to 12 parts of sand and 15 per cent. of hydrated lime. (If white color is desired, use Medusa white cement and local white sand). The above materials to be well mixed dry, then tempered with water, to which has been added one part of the waterproofing paste to every 18 parts of water.

Application of Stucco: Straightening Coat—Care has to be taken that the surface is thoroughly saturated with water to insure perfect blend, then apply straightening coat. Bring the surface to a true and straight condition, using a traversing rod. (No darby float to be used on first coat). Then scratch the surface with a wire or nail scratch. (This gives an under cut and insures good bond).

Application of Finish Coat for Smooth Surface—If stipple, use same process, only stipple before set. If rough cast, dash the finish material with a broom. Thoroughly saturate the first coat surface with water until it presents a glaze appearance; when this glaze disappears, which will be in a few minutes, apply the finish mortar, which should not be too soft, and bring the surface to a true condition with darby float. When the mortar will permit, go over the surface with hand float, bringing to a true finish free of cat-faces or voids; the entire surface to be gone over with burlap or hand float and patted to take out float marks. No joints to be allowed in the work where they can be seen. The entire surface to present a uniform appearance in color and texture. Mortar should be applied as quickly as possible and at all times protected from the sun.

Protection—Special care should be taken to avoid too rapid drying; if in the direct rays of the sun, the mortar shall be protected with burlap or wet canvas, and when sufficiently resistive, should be sprinkled with water for at least six days.

Stucco on Metal Lath—If stucco on metal lath, specify three-coat work with good fiber in first and second coats, waterproof in second and third coats.

Forming Molding—Cores for molding shall be formed of concrete by concrete contractor, allowing about one inch for finish. All molding to be run and finished with hand float to give same texture as rest of surface and to help bind the surface. When a condition arises where a heavy coat of mortar is necessary, a key for the mortar shall be formed by driving galvanized nails into the core.

Railway Question Discussed at Saskatchewan C. S. C. E.

An important meeting of the Saskatchewan Branch of the Canadian Society of Civil Engineers was held in Regina on May 21, to read and discuss papers bearing upon Canada's railway problems. Commissioner L. A. Thornton, Regina, chairman of the branch, presided. Mr. O. W. Smith read a paper, prepared by Mr. W. F. Tye, on the railway question. This paper has already received considerable publicity. Mr. H. S. Carpenter presented a paper on the same subject which had been written by Sir Thomas Tait. Mr. de Stein reviewed the majority report of the special Railway Commission which held an enquiry into the Canadian railway situation some time ago, and Mr. E. J. W. Montgomery read the minority report of this commission. Among prominent engineers who were present and some of whom took part in the discussion, were A. E. Stevens, general superintendent, C. P. R., Moose Jaw; J. H. Chown, C. P. R. superintendent, Regina; Mayor Cowan, Regina; W. P. Warner, chief engineer of telegraphs; W. H. Green, city engineer, Moose Jaw; H. S. Carpenter, Deputy Minister of Highways for the province; J. R. C. McCredie, C. P. R. Engineer, Moose Jaw; J. Henderson, and Secretary de Stein.

Record Span Across St. Lawrence

The Shawinigan Water and Power Company are preparing designs for a 5,000 foot clear conductor span for the transmission of electric energy over the St. Lawrence River at Three Rivers, Que., which will supplement the submarine cable transmission line already installed. The two steel towers on which the line will rest at the extreme ends of this long span will have a concrete base, set some little distance from the bank of the river. These towers will be 350 feet high so as to provide a clearance of 160 feet in the centre of the span. The three conductors will be placed approximately 50 feet apart. The transmission line will not be anchored to the towers themselves but merely supported by the towers and anchored to concrete blocks located some distance to the rear of the towers.

Concrete Poles by the Centrifugal Method

An Adaptation of a European Process of Manufacturing Poles — Partly Filled Mold of Concrete Whirled in Lathe

OWING to the increasing difficulty of obtaining timber poles, concrete poles of proper construction are being regarded as affording a practical solution of the problem. The solid variety of concrete pole has many disadvantages—excessive weight, liability to breakage and difficulty of transportation. The hollow type as ordinarily constructed with a collapsible core has solved the weight problem, but such poles are difficult and costly to manufacture and are quite unreliable in shearing value from the ground line to the butt. In Europe, a centrifugal process for the manufacture of hollow poles has been in use for some time. In effect the method involves the whirling of a partly filled mold of concrete about its longitudinal axis in a giant lathe until the concrete has been forced into a hollow cylinder. This method has recently been adopted on this continent and poles are now being produced commercially. A detailed description of the process employed in the manufacture of poles by the centrifugal method was given by W. H. Lienesch, chief engineer of the Universal Concrete Products Company, at a meeting of the Association of Railway Telegraph Superintendents at Chicago. The following covers some of the features of the design and manufacture:—

A simple and practical machine has recently been perfected which employs the powerful principle of centrifugal force and produces a round, hollow concrete shaft which is believed to possess all of the desirable qualities required by pole line engineers.

The Process of Manufacture

The operation of the centrifugal process is briefly described as follows:

The lower half of a circular metal form is placed on rollers set in line with a special machine, which is constructed so as to revolve the form in a horizontal position. This half form is filled with wet concrete material, a fabricated cage of reinforcing steel is laid into the concrete, the upper half of form is placed in position and the entire form, concrete and steel, is rolled into the machine. Special clamps in the machine are used for the purpose of holding the halves of the form together. After the form is securely clamped in place, the machine form, concrete and steel, is revolved for a period of several minutes at a high rate of speed. During this action the centrifugal force which is developed from such speed causes the concrete to be compressed against the inside of the form with a pressure varying from 75 to 300 pounds per square inch, producing a dense concrete structure having a smooth hole through the centre and walls tapering in thickness from end to end.

During the mechanical action of this process, all air bubbles and other voids are entirely eliminated from the plastic mass of concrete, and owing to the difference in specific gravity between water and the aggregate, the water is caused to flow toward the centre and is finally expelled from the pole by pouring out of the large end through its own gravity. The immediate elimination of a great percentage of its moisture, causes the plastic material to set up into a firm body which bears considerable rough handling before the initial set has occurred in the cement.

Immediately after the pole is turned it is removed, in the form, from the machine and allowed to set for a period of 12 hours, after which the upper half of form is removed and the finished pole is rilled out of lower half into a bed of fine sand. The pole is then allowed to harden for 96 hours, at which time it is removed to a storage yard and is ready for shipment after being cured under water for a period of ten days.

The Reinforcement

The forms and steel cages of reinforcement used in connection with the centrifugal process are so constructed that the steel is positively retained in its figured position, being in the centre of the concrete wall at the pole top and having one-half inch of exterior concrete protection along the entire pole length. The steel cages are woven in a special loom which accurately spaces the longitudinal bars about the perimeter of the cage, and winds them with an exterior spiral of steel wire having a varying pitch which is closest at the base of the cage. The use of numerous small units of steel, some of which are stopped off at various points along the length of the pole, permits the graduation of sectional area from a minimum at the top to a maximum at the ground line. The combined action of the exterior spirals together with the varying thickness of the concrete inside of cages, prevents the bars from buckling in any direction, so that the full compression value of the steel is developed along the entire length of the bars giving the pole a varying strength, being greatest at the ground line. This pole possesses the required strength right where it is needed and eliminates the waste of materials where such strength is not required.

Pole Will Stand Heavy Loads

The use of high-carbon steel longitudinal bars, having an elastic limit of at least 55,000 pounds per square inch, and bright steel exterior spiral wire with a tensile strength of 85,000 pounds, combined with very dense concrete, averaging about 3,000 pounds per square inch, produces a concrete pole, through the centrifugal process, which can be designed to withstand very excessive working loads. The weight of a properly designed round, hollow horizontal pole is 50 per cent. less than that of any solid concrete pole of equal strength, and only two and a half times that of the best cedar poles, which have only one-half the strength of the concrete pole.

Shear in Hollow Poles

The results of many tests show that hollow concrete poles usually fail in "shear" from the ground line to the butt. This shearing action which occurs on both sides of the pole along longitudinal lines, coinciding with the plane of the neutral axis, can be overcome through the provision of horizontal reinforcement against vertical shear. The cages of reinforcement in a properly designed concrete pole should be fabri cated with numerous small longitudinal units evenly spaced about the perimeter of the pole wall so as to provide a uniform thickness of exterior concrete protection over the bars. This thickness of concrete should never be less than one-half inch and is usually figured at one and one-half times the greatest bar diameter. High tension exterior spiral winding is an essential factor in the strength of concrete pole reinforcement. Such spirals prevent outward buckling of bars on the compression side of the pole. The thickness of concrete walls inside of longitudinal bars should be so designed as to resist the inward buckling of bars in compression. The ultimate strength of hollow concrete poles which are designed so as to properly resist shearing and compression stresses is determined entirely by the elastic limit of the longitudinal bars acting in tension. With this point in mind, it can be clearly understood that concrete poles which are subjected to their figured ultimate loads, will deflect to a point of permanent deformation, and remain firm in their distorted position without failing entirely and precipitating the wires to the ground. Considering the importance of uninterrupted service, this characteristic in concrete poles is of extreme value to all public service companies.

Very interesting facts are brought out in connection with the calculation of stresses which occur in round hollow concrete poles. Being distributed in a circular position only two of the longitudinal bars can be stressed to their full value. These bars are on opposite sides of the pole in the same plane as the load line, and being farthest away from the neutral axis, the percentage of stress which is developed in the balance of the bars is gradually decreased until a point of zero is reached in two bars which are in the plane of the neutral axis. A hollow round concrete pole is equally strong with the load taken in any direction.

Pole Design

The maximum number of longitudinal reinforcing bars which can be economically used in the construction of hollow poles is governed by several factors. The ratio between the area of steel and the gross area of the pole may vary between 3 and 5 per cent. The number of bars is governed by the diameter of the steel circle. A minimum distance equal to three bar diameters must be provided between the bar centers when measured on the perimeter of the steel circle. The pole diameter will necessarily vary with the load. In determining proper pole diameters, excessive pole deflections must also be considered. The design of centrifugal poles has been made with reference to three classes of loading. Assuming wire spans of 100 feet, with 20 per cent. of the total pole length in the ground, Class A will withstand a horizontal pull of 4,500 pounds applied at a point 5 feet from top; Class B, 2,650 pounds, 3 feet from top, and Class C, 1,500 pounds, 1¼ feet from top. A standard taper equal to one-quarter inch per foot of pole length has been adopted. The top diameters are 5¾ inches for Class C; 7 inches for Class B, and 8¼ inches for Class A. The diameter of butts, of course, varies with the pole length.

Chlorine Made by Montreal Water and Power Company at Considerable Saving

THE Engineering News Record reports the description of Montreal's chlorine manufacturing plant, given by F. H. Pitcher, chief engineer, and J. O. Meadow, superintendent of the Montreal Water and Power Company. The following items, taken from the description, are of interest to large municipalities using chlorine for purification purposes, as the figures indicate a very considerable saving in cost of material:

The sterilization of public water supplies with chlorine or chlorine compounds is now standard practice, and this method is well understood; but the production of electrolytic chlorine and the direct application of the gas so produced to the water to be purified is of rather recent date, and, except in a general way, is but little understood by the waterworks fraternity.

The electrolytic-cell installation of the Montreal Water and Power Company has been in service since only the first part of 1917, but during that time many interesting data have been secured.

The chlorine-cell installation includes a salt-storage bin having a capacity of 40 tons of salt, the brine saturating and purifying equipment, two 15 h.p. motor generator sets, four chlorine cells, and the silver ejectors and distributing lines for applying the chlorine water to the water to be treated.

The brine saturating purifying equipment consists of three vertical galvanized iron saturators, 27 in. in diameter by 6½ ft. in height, provided with a spray system at the bottom and an outlet 6 in. from the top and two concrete reaction tanks having a capacity of 82 cubic feet each. These tanks are built with sloping bottoms, and have a pipe grid for air agitation. Two sand filters are provided for filtering the purified brine, which passes from the filters to the two concrete storage tanks, having a capacity of 276 cubic feet each.

The distributing lines for applying the chlorine water to the water to be treated are 1 in. chemical hose lines. The chlorine gas is ejected into the water by means of a silver ejector, which maintains a 4 in. vacuum on the chlorine cells and takes the gas from the chlorine main through the ejector to the distributing lines.

Allen-Moore Chlorine Cell

The electrolytic cell is of the Allen-Moore type. It is a standard 600 amp. cell, and is 7 ft. long by 20⅜ in. wide. Each cell is provided with Acheson graphite anode plates and pure wrought-iron perforated cathode plates. The Allen-Moore cell is of the unsubmerged diaphragm type and uses asbestos paper for the diaphragm material. Unlike several other types of electrolytic chlorine cells, the cell box of the Allen-Moore cell is made of concrete, properly protected at the surface to withstand the chemicals.

The cells are connected in series, and are provided with short-circuit switches or cutouts. The voltage carried on each cell is approximately 3.3 volts, and each cell is capable of producing 32 pounds of chlorine per 24 hours.

In preparing the brine solution a small quantity of water under pressure is allowed to flow in at the bottom of the saturators, the saturators being charged with salt. A saturated solution of salt is delivered to the two concrete reaction tanks. A sufficient quantity of soda ash is added to the brine in the reaction tanks to combine with the calcium and magnesium salts present in the brine, and the contents of the tanks are agitated for one-half hour to insure complete mixing of the soda-ash solution with the brine and also to hasten the reaction. The solution is then allowed to remain in a quiescent state for one hour to allow the precipitate formed to settle, when the solution is filtered through the sand filters into the purified-brine storage tanks. A sample of the purified brine is titrated for residual alkalinity, which determines the amount of hydrochloric acid necessary to neutralize the alkalinity and leave a residual acidity of about 0.01 per cent. It is necessary to have the electrolyte slightly acid to prevent the formation of hypochlorites within the cell and the subsequent loss of cell efficiency.

Cost of Chlorine Production

The annual cost of production is estimated as follows:

Salt at $8 per ton	$ 500
Power at $30 per horse-power	450
Interest at 6 per cent. on $5,000	300
Depreciation at 15 per cent.	750
Labor and superintendence	500
Total	$2,500

Three chlorine cells furnish the requisite amount of chlorine for sterilization, yielding 90 pounds of chlorine gas per 24 hours, or 32,850 pounds per year, making the cost of chlorine produced 7.6c per pound.

Comparison With Hypochlorite Cost

The annual cost of sterilization previous to the installation of the chlorine cells was as follows:

Chloride of lime at 3.75c per pounds	$4,105
Interest at 6 per cent.	150
Depreciation at 5 per cent.	125
Labor and superintendence	500
Total	$4,880

As the amount of chloride of lime required was 300 pounds per day, or 100 pounds of available chlorine, the cost per pound was 13.4c, or 5.8c per pound more than chlorine produced by the electrolytic cells.

With normal market conditions the annual cost of the two forms of treatment would be approximately the same, if one did not consider the general depreciation that chloride of lime causes about a water-purification plant.

Operation of Chlorine Cells

An electrolytic chlorine cell functions at its best when under a constant current load, and for this reason it is good practice not to vary the load, or, if varied, to bring about a change gradually. Variations in load cause a considerable deterioration of the diaphragms, with a consequent loss in cell efficiency. For this reason automatic control of the chlorine production from an electrolytic cell is not practical; and for the treatment of a large volume of water, without appreciable variations in volume, automatic control is not required, for the dosage can be regulated for the maximum requirements without causing tastes or odors during the minimum-consumption periods. The three cells required to supply the chlorine consumed for sterilization are operated with a current load of 500 amp. and 13 volts. The electrolytic cells require very little attention, and up to date have given excellent satisfaction.

The caustic liquor from the cells contains about 12 per cent. of sodium chloride and about 10 per cent. of NaOH. No recovery of the salt and caustic is attempted, because the amounts of these two chemicals produced are so relatively small that their recovery would not be economical. For large installations the recovery of the salt and caustic is a regular feature of the process, the salt recovered being used over again and the caustic being concentrated and sold as liquid caustic.

Reasons for Adoption

The chlorine cell installation was adopted because of the saving effected over the present high price of chloride of lime and because of inability to secure this chemical with any degree of certainty; also, because common salt is very much better to handle around a water-purification plant and its use in the chlorine cells does not cause the general deterioration about the works that the use of chloride of lime does. Overdosage with chlorine does not cause the trouble that chloride of lime overdosage does, because odors and tastes are not present to the same degree.

Pile-Driving Under Unusual Conditions

In the recently issued proceedings of the last convention of the American Railway Bridge and Building Association the following example of pile-driving methods to meet unusual conditions is recorded:

On certain parts of the Canadian Northern Railway deep muskegs are encountered, the grade line of the railway being but a few feet above the surface of the muskeg. Piles longer than the driver leads are often required in these places. Sometimes the piles are raised and dropped vertically, outside of the leads, several times, until sufficient penetration is obtained to allow them to go under the hammer. At other times sufficient penetration cannot be obtained in the above manner, and it is then necessary to lash a tapering timber to the side of the pile. Light blows of the hammer are applied to this timber until the pile will go under the hammer and regular driving can proceed. A deep and rather soft clay also has been encountered. This is too deep for the point of the pile to reach firm bottom, even though splicing of piles may be resorted to. In such cases timbers are bolted on, giving a horizontal cross-section of the pile resembling a Maltese cross. This enlarges the surface of the pile in contact with the clay, and has given satisfactory results when used with discretion.

Developing Copper Mines

The Tidewater Copper Company, a subsidiary of the famous Guggenheim Corporation, is developing its extremely promising copper workings at Sydney Inlet, on the West Coast of Vancouver Island. To this end an order aggregating fifteen carloads of machinery was placed some months ago with the B. C. Equipment Company, Limited, Vancouver, and delivery is now being made. A considerable portion of the order has already gone forward and every steamer serving West Coast points carries other consignments which are eagerly looked for by Superintendent Silverman. When the mine becomes a producer the ore will be shipped to the new smelter at Ladysmith, on the east coast.

Proportioning Concrete by Specifying Constant Percentage of Cement

By H. C. Johnson*

A COMPARISON is here made of the usual 1:2:4 method of proportioning concrete with one in which, no matter what the aggregates may be, the quantity of cement in the finished material remains the same for any given volume.

The percentage of dry cement, by volume, contained in the extremes of 1:2:4 concrete will vary all the way from 18 per cent. to as high as 24 per cent.

The proposed method ensures a constant percentage of cement in the neighborhood of 20-21 per cent., and a specification based on the method would do at least two things:

(a) Demand that exactly the same quantity of cement should enter a structure, whether it be built with gravel as the aggregate, or with broken stone as the aggregate. (Such would not be the case when it is specified that 1:2:4 must be the proportions.)

(b) Give a contractor or any other person the correct volume, and therefore the correct weight, of cement that the volume of the concrete in the structure will demand.

Another part of the method is that some large aggregates are given less sand than others: therefore, the ratio of sand to large aggregate is not in the proportion of 2 to 4, but depends on the "workability" and weight per cubic foot of the concrete. It demands that actual tests to determine the proportions shall be made of those materials which it is intended shall go into the job, and therefore prevents an excess of fine stuff being used ,as would otherwise be the case.

The tests show that the weight per cubic foot is increased from two pounds to three pounds, while in one or two cases the addition in strength is as great as 500 pounds per square inch at 28 days. In other cases there is an addition in strength, even when less cement is used.

Details of Method and Tests

It is well known that gravel and some other concretes, when mixed 1:2:4 are not as strong as hand-broken stone concretes; also that the larger the aggregate, other things being equal, the stronger the concrete.

(a) 1:2:4 gravel concretes are, on the average, about 12-15 per cent. weaker than stone concretes. They contain also, on the average, 10-15 per cent. less cement.

(b) Three-quarter inch aggregate concrete is stronger than ¼ in. aggregate concrete, while 1½ in. aggregate concrete is stronger than either. The ¼ in. aggregate has 500 per cent. greater surface for its volume than the 1½ in. aggregate.

For the present we will leave out the question of strength and consider only the amount, or, better still, the volume percentage, of cement in various 1:2:4 concretes. After all, the cement is the only thing that "cements," and the more of it, all other things being equal, the stronger the concrete.

Before going further, I shall assume that you will admit the truth of the following facts:

(a) Sand, stone, and gravel are inert materials, with absolutely no cementing power, and are only used to dilute neat cement, because neat cement would be too expensive to use alone. (This is quite apart from the question of using neat cement alone, since no one would use neat cement so.)

(b) Aggregates possess voids, or air spaces, ranging from 25 per cent. to 50 per cent. of the gross volume they occupy.

(c) It is incorrect to speak of a 1:2:4 mix as a 1:6 mix, since it may convey the impression that 6 parts of sandy gravel with 1 of cement is the same as 4 parts stone and 2 parts sand with 1 of cement.

It is very necessary to state that all measurements were made by loose volume (in the proportion 4 large aggregate, 2 small aggregate, to 1 cement), just as would be made on the job.

The experiments illustrate the following facts:

(a) Some 1:2:4 concretes contain more cement than other 1:2:4 concretes, often as much as 29 per cent.

(b) Stone concretes on the average contain 10 per cent. more cement than gravel concretes. It is, therefore, not fair to expect gravel concretes to be as strong as stone concretes.

(c) The percentage of voids in gravel being smaller than in stone, less sand should be used—1½ parts of sand (on the average) to 4 parts of gravel will produce a concrete worked as easily as, if not more easily than, 2 sand to 4 stone.

(d) Gravels passed through and retained on screens as used for stone always have less voids; the popular idea is that they would be the same. It can be admitted that if stone could be "hand placed" into a receptacle, a very small percentage of voids would result. This indicates that stone concretes, unless they had considerable sand (2 to 4), would not be so reliable as gravel in the matter of density.

(e) Gravel concretes mixed 1:2:4 are three pounds per cubic foot lighter than stone concretes. Proper proportioning will easily make up this three pounds in spite of the fact that the specific gravity of gravel is only 2.51, as against 2.70 for stone.

I have used the terms large aggregate and small aggregate on purpose to draw attention to the fact that sand is only finer gravel, or granite or quartz, is an inert material just the same as the larger materials, and has to be "cemented" by the cement, just as the larger particles. It is no use talking of mortar filling the voids, or anything of that sort. Mortar is used by bricklayers and masons to bed two plane surfaces together; concretors use inert aggregate and cement with which to bind it together; but the outstanding fact is that the smaller the aggregate (all other things being equal) the weaker the concrete. There is no need to quote authorities; they are many, and have established the fact. In view of this last, the less fine aggregate (sand), providing a thoroughly workable concrete is produced, the better.

Statements have been made and tests devised to prove that:

(a) Reducing the percentage of voids to the absolute minimum possible, and filling these with cement, produces the strongest concrete.

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*Read before the Concrete Institute.

(b) Any cement beyond that necessary to fill these voids is waste, and does not increase the strength.

(c) Just as a carpenter uses the minimum of glue in making a joint, so one should use a minimum of cement in making concrete.

It may be admitted that, all other things being equal, the more cement the stronger the concrete. Gravel concrete has suffered for years, because for apparently equal quantities of cement it is not as strong as stone concrete.

The whole trouble lies in the fate that the amount of cement is not based on the finished volume of concrete.

Gravel Aggregates v. Stone Aggregates

I speak of gravel concrete having suffered for years because, when mixed 1:2:4, it is not usually so strong as broken stone concrete. This is because many engineers will not look at gravel as an aggregate if they can get broken stone. If I have succeeded in showing that it is not fairly treated in the matter of cement content, and if, later on, I also succeed in showing that it is unfairly treated in the matter of sand in combination with it, I shall believe that it will be considered equally as good as, if not better material than, broken stone.

Large Aggregates v. Smaller Aggregates

If we can, let us consider ourselves small enough to be able to wander about in the interstices of two different mixes of concrete—in one case a large aggregate concrete and the other a smaller aggregate concrete.

We would find in each case that small globules of air had attached themselves to the surfaces of all the materials making up the concrete; we would also find that, owing partly to the "bridging" of all the particles, and partly to insufficiency of very fine material, there would be other passages and cul-de-sacs, then there would be some particles of cement engaged in sticking to the surface of the inert material, while still other particles would be sticking together in pairs and in three and fours.

In the large aggregate concrete we would find that, owing to the smaller surface area per unit volume of each piece there would be less cement adhering to the inert material and more cement particles in contact with one another. There would also be a smaller total length of passages and cul-de-sacs.

Now, I suggest we assume that each cement particle where it comes into contact with inert material has an adhesive value of one, but where it comes into contact with another cement particle it has a cohesive value of two or thereabouts. If, then, we have a smaller surface area per unit volume in one aggregate than another we must have a greater cohesive value, and therefore greater strength

Large aggregates should have large sand, while smaller aggregates should have small sand. Even very fine sand, if of first quality, will give a concrete as strong as one with coarse sand if properly proptioned —i.e., less of it used, which will be the case if the correct proportions are found by a trial mix, in which one must aim at producing the heaviest concrete using those materials.

Having now decided two things—(a) that any concretes made up for comparative test values of different aggregates should all contain the same percentage of cement, and (b) that some large aggregates do not require so much sand as others, we (in the University Laboratory, Cork) proceeded to make up what we are pleased to call "corrected concretes" and also 1:2:4 concretes for comparisons of cement content and strength.

Materials Used in the Tests

For these specimens we mixed two brands of cement (a) South Wales P. C. Company's; (b) Magheramorne P. C. (A.P.C.M.). We had the following aggregates: County Cork sandstone gravel; County Kildare limestone gravel; County Cork crushed sandstone; County Cork hand-broken limestone; County Wexford fine quartz sand; Leighton Buzzard sand, kindly supplied by Joseph Arnold, of Kentish Town.

All large aggregates were washed and passed over the following screens: ¾, ⅝, ½, ⅜, ¼, ⅛, and only material passing the ¾ in. and retained on the ⅛ in. screen was used.

The fine sand was so fine that two-thirds of it passed the 1/50 in. sieve. The Leighton Buzzard sand was the run of the pit, and varied between 1/10 in. and 1/40 in.; it is really a medium sand, but we called it our coarse sand, since the other was so fine.

Each aggregate was made up with both fine and coarse sand, thus giving eight sets of specimens.

Conclusions

1. The 1:2:4 method of proportioning should be considered obsolete, since no two 1:2:4 concretes contain the same percentage of cement; neither does it allow the majority of materials to produce their best values.

2. An actual test of the materials it is proposed to use should be made, introducing the percentage of cement required for the particular purpose the concrete is for and finding the ratio of small to large aggregate accurately by this means.

3. Other things equal, the percentage of cement closely governs the strength. Other things equal, the larger the aggregate the stronger the concrete.

4. Previous tests proved that washing the average aggregate carefully will allow 30-40 per cent. higher strength in a hand mix, but only about 15-25 per cent. in a machine mix. This is always excepting really dirty material.

5. Using a mixer and giving two to three minutes for mixing will give a concrete, other things equal, about 50-75 per cent. stronger.

6. For equal working consistency and equal cement gravel concrete is as strong as stone concrete.

7. Gravel passing same screens as stone always has less voids than the stone.

8. Fine sand concrete has smaller weight per cubic foot than coarse sand concrete.

9. Fine sand plus large aggregate (without cement) gives smaller volume than coarse. Fine sand plus large aggregate (with cement) gives larger volume than coarse.

10. Fine sand concrete is easier worked than coarse sand concrete for equal amounts of sand.

11. The finer the aggregate the more deleterious material and air it carries with it into the concrete.

12. The finer the sand the less should be used.

13. Thirty to forty per cent. higher strengths are obtained with 3.16 in. cubes than with 6 in. cubes.

14. Small cubes are more uncertain and inconsistent in the strength values than larger cubes.

15. In the future, and in order that tests at various places shall be truly comparative, two things are required: (a) The percentage of cement in the concrete; (b) the strength of the cement in mortar tension or mortar compression.

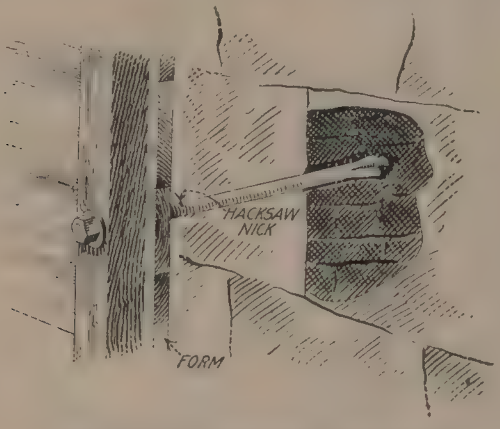
Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Anchor Bolts Hold Form Where Bracing is Impossible

By Samuel Warren

Anchor bolts were used as shown in the sketch to secure the form for facing with concrete an old retaining wall of dry masonry which was in such a location that there was no chance to brace the forms. The wall, of dry masonry, supports a section of a railroad line that runs along the face of a cliff about 100 feet high. The wall extends down to a ledge about 50 feet below the track. This ledge was about 10 feet wide outside the old stone wall, and the working space was still further reduced by the thickness of the new wall, which was 4 feet at the bottom and 18 inches at the top.



Form anchored to face of stone retaining wall.

Except for the first few feet, there was no possibility of bracing the forms, and it was necessary to tie them to the existing wall. This was accomplished by making up bolts of ⅝-in. round rods, one end of each of which was split for about 2 ins. to receive the wedge. Holes 5 inches deep were drilled into the stone of the old wall, into which the split ends of the rods, with small wedges inserted, were driven. After the rods were placed, the form construction proceeded in the ordinary manner.

As it was impossible to remove the bolts after the forms were stripped, they were nicked with a hacksaw about 1 inch inside the face to facilitate removal. When the forms were taken off, a few sharp blows with a hammer knocked off the ends of the bolts inside the surface, and the holes were plastered up.—Engineering News-Record.

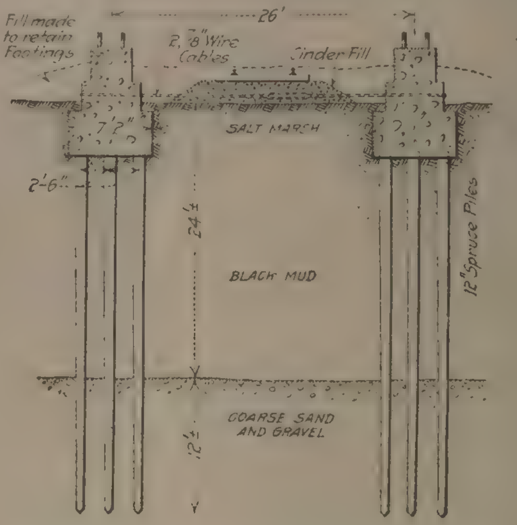
Trolleys and Hoists Handle Forms

Steel forms 20 ft. long for a 10-ft. sewer at Columbus, Ohio, have been very satisfactorily handled by chain hoists and three-wheel trolleys running on 7-inch track channels suspended from the transverse trench bracing above the springing line of the arch. Two men pull them forward with a two-part tackle and a gang of five men moves and sets them and attends to the bracing for a 60-ft. length of the sewer in about three hours, the same force and the same time being required to set the arch forms moved with the usual arrangement of rollers and track at skewback level.

Spread Piles Straightened by Turnbuckles

Writing in Engineering News-Record, A. P. Roscoe describes a method of using turnbuckles for pulling back piles and piers that had spread in soft ground. The column footings in question were for a three-track elevated railway in Brooklyn, N.Y., and were constructed across a swamp in which the mud varied in depth from 15 to 30 feet. The piers were supported on spruce piles 30 inches on centers, which were driven to refusal with a 2,000-lb. drop hammer into the sand and gravel underlying the mud.

Over the greater part of this swamp there was an ash fill 6 or 8 feet in depth, which had been in place some six years. This fill served to give lateral stability to the footings. At one point, however, near a creek, there was no fill on the original salt marsh. Here it was brought home forcibly to the engineers that piles driven in soft material, although able to support the load brought upon them, have little lateral strength, and that a structure supported on piles under such conditions is liable to injury if a horizontal force is brought to act on them.



Turnbuckles straighten piles that had spread in soft ground.

The piers at this point are 7 ft. 2 in. by 9 ft. 8 in. in plan, supported by 12 piles each; they carry a load of 145 tons. The contractor laid a standard-gauge track on a cinder fill about 2 ft. deep between the two lines of piers, and used a 50-ton locomotive and flat-cars to haul structural steel. The load of 35 tons per car axle which was thus brought to bear on the underlying mud forced it out laterally against the piers. It sprung the piles and spread the opposite piers apart 2½ inches in the bent in question.

In order to repair the damage, two ⅞-in. wire cables with turnbuckles were passed around the piers. By drawing these up, it was possible to pull the piers back to correct position. An earth fill was made around the footings to retain them in their proper position, the cables being left in place as an additional precaution. The sketch shows the resulting conditions.

"Portland" with a Small "P"

The Portland Cement Association suggests that there is no good reason for writing "portland cement" with a capital "P," since the product is not made in Portland, Me., Portland, Ore., nor Portland, England. The association recommends this practice to members in the following paragraph:

The emphasis resulting from the capitalization of the letter "P" contributes to the erroneous impression so prevalent that Portland cement is all made by a single corporation—hence such frequent expressions as, "Oh, yes! you are with the Portland people," or "What is the address of the Portland Cement Company?" The word "Portland" is properly to be considered as a qualifying adjective used to distinguish a kind of cement, not a brand of cement or a trademark. The case is quite similar to that of "macadam roads," where the word "macadam" has become a common adjective, though derived from MacAdam, the name of the man who invented this type of road. It is believed that departing from the custom of capitalizing the word "portland" will do much to correct the present troublesome misconception.

Trenton Collegiate

(Continued from page 497)

nasium, boys' and girls' dressing rooms and lavatories.

The floors of the class rooms will be of maple, and all interior finishing will be Georgia pine. The floors of the corridors will be of reinforced concrete finished with Terrazzo. The entrances and the lavatories in the basement will also be floored with Terrazzo. Stairs will be of steel with mastic treads. The steps leading to the entrance will be of reinforced concrete.

In arranging for the lighting, provision has been made for a glass area of 8 ft. x 17 ft. in each class room. The heating is by steam, with forced fan ventilation and temperature control.

The building has been so designed that at a future date wings may be added at both ends without disturbing the arrangement of the present structure.

Architects and Contractors

Schultz Brothers, of Brantford, Ont., who have been awarded the general contract, have just started work on the building, which is to be completed before the end of December this year. Fully equipped and ready for occupancy it will cost about $70,000. The architects are Messrs. S. B. Coon & Son, of Toronto.

Industrial expansion is causing a shortage of houses at Trenton, Ont. The population of this town has been doubled within the last six months, due to the construction of extensive manufacturing plants, and the matter has been taken in hand by an Industrial Committee, to whom communications should be addressed.

Mainly Constructional

East and West—From Coast to Coast

The Cresson Construction Company, Ltd., has been incorporated, with a capital stock of $20,000, head office at Montreal.

The Colonial Lumber Company's mills at [illegible], Ont., have been destroyed by fire, resulting in a loss of about $110,000.

The Standard Gravel Company, Limited, has been incorporated, with a capital of $40,000, head office, Niagara Falls, Ont.

Mr. F. Neil Brodie, architect, of St. John, N.B., has prepared plans for a large school building to be erected at Lancaster, on the western side of the harbor.

Dr. Howe, of the University of Toronto, in co-operation with the Laurentide Company, Ltd., is to carry out a survey of the cut-over pulpwood lands for the Commission of Conservation.

The municipality of Burnaby, B.C., has received a government grant of $15,000 for work on the Barnet Road, but it is stated that nothing will be done on the road until an engineer has been procured.

At a special meeting of the Town Council of [illegible], Ont., recently, a resolution was passed petitioning the Provincial Government to commence work as soon as possible on the proposed provincial highway.

Work is being commenced by the Shawinigan Water & Power Company at Three Rivers, Que., on a reinforced concrete caisson, 60 feet square and about 50 or 60 feet high, to replace wooden cofferdam and piles.

Active building work is reported in the Earlscourt and Oakwood section of the city of Toronto. At the present time over fifty up-to-date houses are in various stages of con**struction, many of which are nearly completed.**

The Hennepin Mining Company, Ltd., has been incor**porated, with head office at Port Arthur, Ont. Boston interests are behind the new firm, which is said to own extensive mining claims in the Thunder Bay and Rainy River districts.**

A report from Banff, Alta., states that the Dominion Government observatory at the summit of Sulphur Mountain has been struck by lightning and almost completely wrecked. The stone walls of the building are cracked and **all the automatic recording instruments destroyed.**

The council of Steelton, Ont., contemplate sinking two pipes of 14 or 16 inch diameter to the wells for their water supply and have taken steps to ascertain the cost of the work. At present there is a [illegible] inch pipe which yields a supply of 700 gallons per minute. A scheme is also suggested whereby Steelton and Sault Ste. Marie may co-**operate in the matter of water supply.**

The earnings of P. Lyall & Sons Construction Company, **Ltd., Montreal, for the year ended March 31** last, totalled **$915,449, an increase of $680,805. Of this amount** $[illegible] is **taken to write down munitions plant and equipment, leaving, after providing for bond interest and sinking fund, $88,899, to** be carried forward. The report states that there is a large amount of building contracts on hand, all of which are on a cost plus commission basis.

The estimated cost of operating the waterworks system of Winnipeg, Man., for the current financial year is $[illegible], and the revenues are estimated at $[illegible]. The expenditures include a balance of $8[illegible],000 for [illegible] the cost of which has [illegible] tion. However, with this amount included, the cost of operating will only be about the same as last year.

The tentative plans for the new plant which the Quaker Oats Company propose to erect at Peterboro, Ont., to replace the one destroyed by fire, provide for an eight-storey factory to be erected at an initial cost of $1,500,000. It is to be a composite building, including flour, rolled oats, puffed rice, and other mills, with elevators, etc.

Mr. R. S. Lea, consulting engineer, of Montreal, recently visited the city of Brantford, Ont., at the request of the Brantford Water Commissioners, for the purpose of investigating the local waterworks. Mr. Lea has been engaged by the commissioners to make a report upon a general plan for a permanent increase in the water supply of the city and to ascertain whether it would be advisable to install a mechanical filter. A large expenditure is not contemplated at the present time, but it is planned to go ahead as soon as conditions warrant.

At a recent meeting of the Greater Winnipeg Water District Board a motion was presented that a committee of five citizens be appointed to act with a similar committee of the board to consider the advisability of closing down the work on the different contracts on the district until after the war. The resolution was not passed, it being pointed out that there were no difficulties in carrying on the work which could not be surmounted, unless something unforeseen cropped up, and that general conditions now existing did not warrant the work being closed down.

The Eaton model road, extending along Dundas Street, from the C.P.R. tracks at Lambton Mills to the Etobicoke River, is to be rebuilt. In 1909 the Eaton road was constructed as a model type of good road, and was a step towards promoting the good roads movement. The great increase in traffic has rendered it necessary to reconstruct the road and the T. Eaton Company has offered to bear 60 per cent. of the cost, which is estimated at over $40,000. The York County Council will be given the money to proceed with the work, and it will be done under their authority.

Work is being commenced on the $3,000,000 coke oven plant for the Dominion Iron & Steel Co. at Sydney, N.S., for which the H. Koppers Company, of Pittsburg, Pa., are the general contractors. The plant, which will consist of 120 ovens, will take from eighteen months to two years to complete, but it is expected that the first oven will be ready for use about March, 1918. The ovens are on the same principle as those now in use, but are of a more modern and improved type, and their construction will be supervised by experts of the By-Products Coke Company of Canada, Ltd.

A delegation representing the Vancouver Board of Trade has laid before Premier Borden and his cabinet an extensive programme for the future development of the port of Vancouver. They urge that the city's waterfront be nationalized and that the expenditures for future improvements and extensions be borne by the Dominion. In justification of their claims they point out that Vancouver has a registered tonnage equal to 25 per cent. more than that of the port of Montreal, a harbor accessible to shipping for twelve months of each year, and a movement of merchandise in and out of the port of over $200,000,000 a year, including the value of the shipments which passed that way en route to Europe and the States from the Orient. In addition to the nationalization of the port and a release from the harbor dues now imposed on all shipping registered at the port, the delegation request the government to build a drydock, to cost $2,500,000.

Personals

Lieut. W. G. McGhie, a graduate of the Faculty of Applied Science and Engineering, University of Toronto, in 1911, has been awarded a medal by the Italian Government for bravery. Lieut. McGhie was formerly with the Canadian Crocker-Wheeler Company, St. Catharines, Ont., and went to France with the 35th Battalion.

Mr. S. S. Scovil, B.Sc., who for the last two years has held the position of engineer to the Dominion Technical Board in connection with the International Joint Commission, has been granted leave of absence to go overseas with the Pioneer Construction Battalion. Mr. Scovil had formerly been assistant chief engineer of the Manitoba Hydrometric Survey.

Major William G. Mackendrick, president of the Warren Bituminous Pavement Company, of Toronto, has been appointed assistant director of roads on the general headquarters staff of the British army in France, with the rank of lieutenant-colonel. He has been in France for the past eighteen months, and during that period has received rapid promotion. First he was attached to the Canadian Corps' headquarters as road expert, with the rank of captain. In a short time he was given command of 1,000 men, and last November he was attached to the British headquarters and appointed deputy assistant director of roads. His latest promotion gives still further proof of the estimation in which his services are held by the military authorities.

Obituary

Mr. George Sage, of Delhi, Ont., well known in that vicinity as a carpenter and builder, passed away recently, at the age of 61.

Corporal Charles C. Bruce, of Forty-fifth Avenue, Kerrisdale, B.C., is officially reported to have died of wounds. Corporal Bruce was formerly employed as chief draughtsman with Stanley, Mitten, Gillingham & Co., a Vancouver firm of architects.

Mr. A. R. Pinsonault, consulting engineer, Montreal, died suddenly on May 24 at the Homeopathic Hospital, Montreal, aged 68. He was at one time engineer on the construction of the I.C.R., and later was on the engineering staff which laid the C.P.R. line on the north shore of Lake Superior. During subsequent years he engaged in consultation work, mainly in connection with railway projects.

Mr. James Spelman, president of the John S. Metcalf Company, Ltd., engineers and grain elevator contractors, died on May 27, after a few days' illness, at his residence in Montreal, aged 56. Death was due to pneumonia. Mr. Spelman was an authority on the design and construction of grain elevators, and his firm have drawn plans for several of the largest elevators in Canada, notably in Montreal and St. John. He recently returned from Australia, where he was in consultation with the governments in reference to building a system of elevators. The firm's activities also extended to Great Britain and Russia. Mr. Spelman was elected a member of the Canadian Society of Civil Engineers in 1902, and read a paper on grain elevators before the society.

Mr. F. J. Robinson, formerly Deputy Minister of Public Works for Saskatchewan and chairman of the Saskatchewan Highways Commission, died suddenly on the evening of May 26, at the Queen's Hotel, Toronto, while he and his family were on their way from Vancouver to St. Thomas. The late Mr. Robinson graduated from the School of Practical Science, Toronto, in 1895, and shortly afterwards went west, where he entered the service of the Government of the Northwest Territories, and became Director of Surveys. Upon the organization of the Provinces of Alberta and Saskatchewan he was appointed Deputy Minister of Public Works, and later chairman of the Highways Commission. He retired two years ago, owing to illness, and had been living out at the Pacific Coast.

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Principal Contents

Page
Editorial 511
Two Well-arranged Mixing and Storage Plants Build 12-Storey Factory 513
Prolonged Flat-Slab Tests 516
Department of Mines is Determining Road-making Value of Canadian Rock 517
British Columbia Clay Plants Have Great Variety of High Grade Materials 520
Large Rolling Steel Door Installation 521
Street Widening to Meet Traffic Demands 523
Factors Limiting the Production of Riveted Work .. 525
Vacuum Street Cleaning in Western Cities 526
Practical Hints for the Contractor 527
Mainly Constructional 529

There is Yet Time to Prepare for a Long War

As the war continues from month to month, it clearly demonstrates the foibles and frailties of human opinions. Various authorities have striven to foresee the end of hostilities and to determine the time when peace will be restored. These prophesies have covered every interval of time from a few weeks to many years. The general hope that this year would mark the end seems doomed to be dispelled. Recent events forebode the war's extension beyond this year at any rate. Just how much longer, no one can say, but no immediate let-up is in prospect. The United States Government, in making its preparation for war, speaks of three to five years as the ultimate duration. If this period is suggested with any authority, and events seem to substantiate the opinion, it is pregnant with meaning. The extension of the struggle for one year more, let alone three or five, must needs involve further readjustments in our status, nationally and individually. The longer it lasts, the louder the call for a more complete nationalization and more potent changes in our mode of living and doing.

* * *

A retrospect of the past well-nigh three years, as far as this country is concerned, shows but little change in the condition of our industrial life. True, trade has expanded, industry in some lines developed, in others become minimized, but on the whole, there is no evidence to show that war circumstances have rebuilt the plane of industrial activity. The war, in many respects, seems to have been taken as an incidental, as a passing event, calculated to cause a flutter for the time being, but of no consequent moment. No doubt the monotony of a drawn-out struggle has served to detract from the advantages such a struggle may have in national life.

In the past there has been too much temporizing, too many makeshifts; no steady course of development has been worked out. Witness many events in the past three years or the present political turmoil. Whatever the past may have developed, however, the future can remedy, and the thoughts of a three-year war to be yet waged is surely a stimulation to activity and to quick organizing thought. The war has developed organization to an extent; it has revised the methods and conditions of labor, made efficiency a watchword, but in the vast occupations and interests of the people the war has not stirred action or stimulated incentive.

Incalculable benefit can be derived from this war in every line of endeavor, but also incalculable harm may result. Industry may take on a new cloak that will give it more permanent and lasting influence if action is spurred. In the past, our intentions were good, but that was as far as it went. The need of planning for three to four years of war, however, calls for more spirited action while there is yet time. Preparation must be on a long-time basis which means a permanent basis. The economists tell us that we will come out of this war a changed nation. The changes will affect every angle of our national life and our industrial relations no less. Now that the war promises to be long, it is time to buck up and retrieve past deficiencies that adequate preparations be made for the changes that are bound to come.

* * *

Just how has construction fared? We are afraid the possibilities have scarcely been realized. In many respects our methods of dealing with construction work have not been adapted to the new situation—in many lines construction has experienced as great a depression as ever known. Many projects were early in the war dropped with an idea of economy. But only a short war period was figured on. Construction, however, for a long period cannot be delayed without permanent injury, and now that a long war seems possible, there is presented an opportunity for a revival. It must be remembered, however, that in reorganizing the whole industrial field and engineering and construction in particular, at this time, there are many factors that must be considered. Unstable markets, uncertain shipments, doubt regarding the actions of our national government, all these impose difficulies that require the relinquishment of conventional methods. These new, in fact radical, conditions, call for an abandonment of old ideas. The pre-war methods must not be allowed to jeopardize the benefits that may be derived from quick action now. Organization of equipment, methods and labor are essential. New devices, new systems, must be substituted for standard practices. These things should have been done months ago, but the need is more pressing now that the war gives indications of prolongment. Let contractors and engineers get busy and plan for this long struggle while the time is yet ripe.

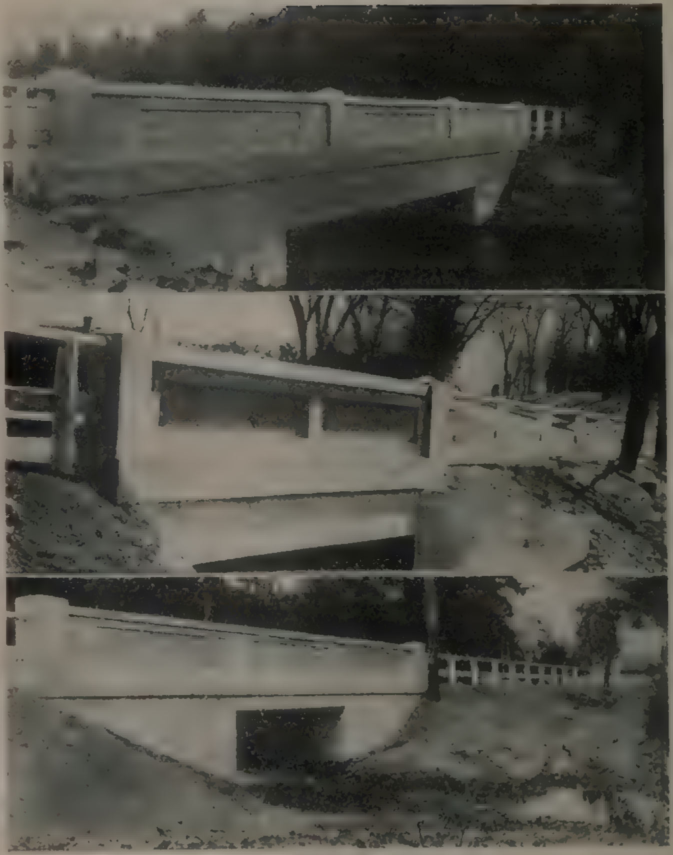
U.S. Technical Organizations Heartily Co-operate in War

If one may judge by the expressions of loyalty to and promises of co-operation with, their president, on the part of the many technical organizations in the United States, the sentiment in favor of abandoning their policy of neutrality finds almost universal favor in that country. It is an old warning to beware of the patient man when he finally loses patience, and there is good evidence that the United States is preparing to lend vigorous assistance to the allies in their struggle for freedom and civilization.

From the least significant to the largest and most important, the technical societies of that country appear to have come forward spontaneously to offer their unqualified aid to the president. That is the first step towards getting results, and it is to be hoped President Wilson will show a proper appreciation of the possibilities underlying these offers. No doubt he will do so, for the United States Government has given unmistakable proof already that it means to take a real part in the struggle. This is shown in the appointment of one of their biggest engineers to have charge of national shipbuilding work, the appointment of a food controller, the immediate co-operation of the navy, and in many other ways. These are evidences of co-operation that Canada, as part of the British Empire, joyfully recognizes as an official guarantee of the innumerable unofficial assurances of good-will and sympathy with which we have been regaled during the past two and a half years.

Ontario Government Advocates Architecture in Bridges

The value of good appearance in structures is a matter that is receiving more and more attention nowadays. It is recognized that the application of architectural adornments to a utilitarian design is a paying proposition and not a waste of money. Bridges, no less than buildings, come under this category, and the tendency is to design them along lines that will appeal to the sense of good taste. Bridges can be made handsome and in keeping with the surroundings with very little effort. The cost is small in comparison with the improved appearance. The Highways Department of Ontario is alive to the need of better-looking bridges, and is urging the counties and townships to build bridges that will be examples of beauty. The Department believes that such structures may quite readily be constructed at little extra expense and in many cases at no additional cost. It has handed us the photographs reproduced herewith as illustrating bridges that are considered models for Ontario bridge builders. Although those shown in the cuts are not located in Ontario, they, in the opinion of the Highway Department, are examples of what might well be copied. The three bridges shown, while of different sizes, show the same aesthetic treatment, which is both effective and inexpensive. Relief from the plainness of solid concrete is effected by simply panelling and giving the panels a pebbled surface. This, combined with plain-end posts, is considered very effective and adds practically nothing to the cost. Attention is also drawn to the neat and substantial approach guard rail.



Types of attractive bridges recommended by Ontario Highways Department

Will Test Moisture Content of New Buildings

Acting in co-operation with the Forest Products Laboratories of Canada, Montreal, some contractors have taken steps to test by means of a hygrometer the moisture in the air of new buildings, so as to determine whether the buildings are sufficiently dry for the placing of fine interior finish without liability to damage from the absorption of moisture by the walls. One of the contractors has also made measurements of moisture in kiln-dried material for the interior finish, checking up the drying conditions.

In several sections of the United States there seems to be developing a more satisfactory labor condition. This is probably due to the completion of many of the European war contracts which have resulted in a release of labor that may now find employment in other channels.

The steel sash for the Montreal Technical School, Sherbrooke Street West, Montreal, will be supplied by the A. B. Ormsby Company, Ltd.

Two Well-Arranged Mixing and Storage Plants Build Twelve-Storey Factory

Flat Slab, Reinforced Concrete Building for T. Eaton Co., Toronto—Steel Cored Columns—Mixing and Aggregate Storage Equipment

A CAREFULLY laid-out, well planned storage and concreting plant, designed for rapid operation, is a feature of the construction of the twelve-storey, reinforced concrete, flat-slab factory building, being erected for the T. Eaton Company, Limited, on Alice Street, Trinity Square, and Downey's Lane, Toronto. This plant, while capable of erecting the building in short order under normal conditions, was severely handicapped by the shortage of supplies and irregular shipments. Consequently the speed planned by the contractors did not materialize to such an extent as was anticipated. Progress is, however, being made as fast as conditions permit, and the concrete skeleton will be entirely poured in the course of another two or three weeks.

The factory for the T. Eaton Company will be a 12 storey flat slab reinforced concrete building. This illustration shows the derrick tower and brick hoist. Forming is proceeding on the tenth storey.

The building is L-shaped, twelve storeys high, with the two outside arms of the L measuring 227 ft. 9½ ins. and 165 ft. 11 ins. on Alice Street and Downey's Lane respectively. The two short faces, fronting on Trinity Square, are 127 ft. 4 ins. and 64 ft. 1½ ins. long. The width of both wings is slightly over 100 ft. The factory will be twelve storeys high with the basement under a portion of the building only. The first floor level is 5 ft. below grade and the storey heights are 14 ft., with the exception of the basement, which has a 13 ft. clearance, and the first two storeys, which have a height of 15 ft. Over 10,000 cubic yards of concrete and 1,500 tons of structural steel will be involved in the construction. The short arm of the building abuts against an existing 12-storey factory, the end wall of which will be removed to provide free access between the two buildings. Across Downey's Lane a bridge is being built to connect the new building with an adjoining one.

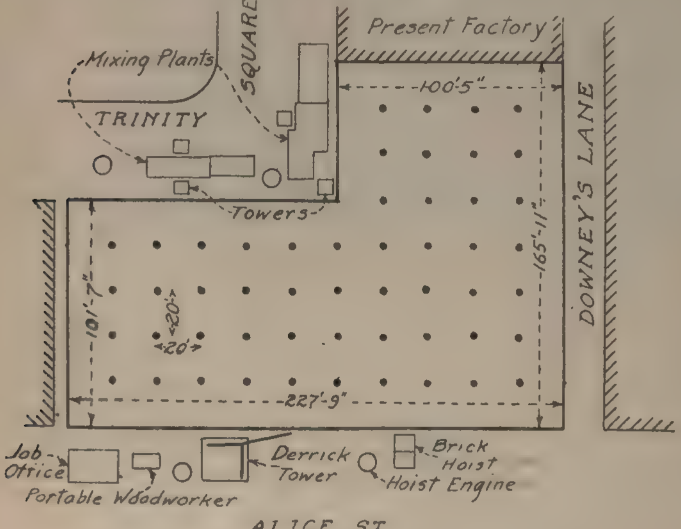
The design has been carried out according to the flat-slab system, with circular columns, flaring capitals and drop heads. The typical bay is 20 feet square. Floor slabs are very heavy, especially the second floor, which measures 11½ ins. with 1½ in. finish. This floor is designed for a live load of 350 lbs. per square foot. The third floor slab, 9 ins. thick, is designed for 250 lbs. per square foot, while the typical floors, 7½ ins. in depth, are designed to bear 150 lbs. per square foot. A special feature of the building is the fact that the columns are steel-cored, the entire load being borne by the steel. This is necessary to keep the lower column diameters within reasonable limits.

The location of the building, in the centre of a busy, down-town, mercantile district, considerably complicated the handling of construction materials. There being no railway facilities, all materials had to be hauled to the site by wagon or motor truck. As the building adjoins streets or existing buildings on all sides and as it occupies the full extent of the site to the street line, the location of a construction plant was consequently hampered. The only open ground was a small vacant lot opposite the new building, and this was used for storage of lumber, reinforcing steel, etc. In designing the construction plant, the situation was further complicated by the necessity of keeping adjoining streets open for traffic. Alice Street, being a through street, had to be kept clear, besides which, the service conduits near the road surface prevented the installation of a mixing plant on this side, owing to the inability to procure the proper depth for its location. The Trinity Square side was therefore selected as a suitable location for the mixers and storage bins, while steel, lumber, brick and similar materials were handled from Alice Street. Even on Trinity Square, a narrow thoroughfare, the proximity of the building to the roadway and the necessity of maintaining a wagonway, added difficulties to the design of a plant of suitable capacity.

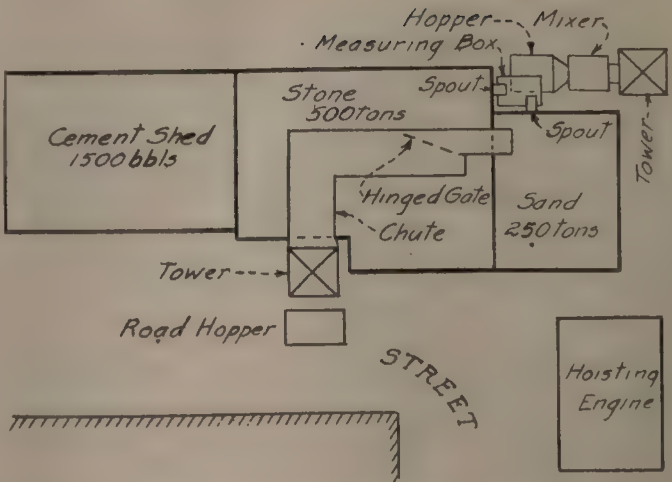
Two Mixing Plants

Two separate mixing plants are being made use of. This enables this work to be carried out more expeditiously than with one, since the area to be covered is quite large. At the same time the total required capacity of the plant is divided into smaller units which avoid blocking the street, as would be the case with a single large plant. Furthermore, there is sufficient duplication to prevent an absolute shutdown from delays or accidents to the plant. The combined capacity is about 400 to 500 cubic yards per ten-hour day. Delays in delivery of steel, however, prevented the plant from being operated at this rate.

The two plants are identical as to principle and lay-out, differing merely in their capacity. They are of the gravity bin type, each involving storage for sand, stone and cement, with approved methods of mixing and handling. The arrangement of the various elements is such as to avoid as much manual handling as possible by using gravity flow of materials to the mixer with mechanical loading of the bins and distribution of the concrete. Concrete is furnished to towers and thence delivered by spouts or buggies. A description in detail of the larger plant will apply to the other in almost every respect.



General plan of building, and layout of construction plant.



Plan view of one mixing and storage plant.

Aggregate-Handling Arrangement

The mixer is located well below grade so as to secure sufficient depth for gravity flow of materials. A cement shed and aggregate bin are provided for storage. Surplus aggregate is also maintained in open piles. The cement shed has a capacity of 1,500 barrels in bags. Accommodation for as much more cement is provided on the ground floor of the building. The storage bin is divided into two compartments, one for crushed stone and the other for pit-run sand, the capacity of the stone bin being twice that of the sand bin. A sump in the roadway, with a large capacity hopper, covered with a pair of trap doors, receives both sand and stone from bottom-dump wagons. A bucket and tower is used to lift the aggregate from the road hopper to the top of the storage bins and discharge it through a chute to the proper bin. The material is deflected to the proper compartment by a hinged board tongue at the mouth of a forked chute with one leg in each bin. A manually controlled gate on the road hopper drops the charge of material to the hoist bucket. The sump and hopper have a capacity of five wagon loads or about 15 cubic yards. This enables a number of wagons to dump without the necessity of immediately hoisting the materials to the bins. Immediate hoisting is not always possible since only one hoist engine is used to operate both the aggregate hoist and the mixed concrete hoist.

The bins are built of 2 x 10 inch planks with 6 x 6 inch vertical wales spaced at about 3 ft. centers and braced with longitudinal and transverse tie rods. For this plant the capacity is 500 tons of stone and 250 tons of sand.

Concrete Placed by Towers

Spouts from the bottom of the bins, controlled by gates, direct the sand and stone to a measuring box arranged to give a 1:2 proportion. A gate drops the charge into the loading hopper of a half-yard mixer. The concrete is carried in bags from the storage shed and the water is measured to a pivoted barrel beside the mixer. The mixer is electrically driven. It is located well below grade so as to secure the depth necessary for gravity flow of aggregate from the bins. The mixed concrete dumps to a hoist bucket and is raised by tower and distributed by gravity chute or buggy to the point where pouring is going on. The tower was increased in height as the progress demanded, the final height being 225 ft. Under normal conditions, a half-yard batch was raised every sixty seconds or less. A single two-drum hoist engine serves to drive the buckets of both the concrete tower and the aggregate tower.

Second Plant is Smaller

The other mixing plant is similar to the one just described, but smaller. It includes a road sump, bins of similar type, tower for filling them, and tower for the mixed concrete. The concrete shed has a capacity of 1,500 barrels in bags, and the stone and sand bins are capable of holding 150 and 75 tons respectively.

Concrete is being spouted from tower. At the right are the aggregate bins and loading tower of one mixing plant.

For the foundation piers and some of the slabs, chutes were employed for pouring the concrete. On the majority of floors, however, buggies were found of greater advantage. The chutes required a great deal of shifting when pouring a large area, like a floor. For portions of the building, like the piers, where the depth was large and the area relatively small, the chutes were more economical. The chutes, largely of a trussed type, were supported on low frame towers and trestles. During the winter, it was found that placing of the concrete with chutes was not altogether satisfactory. It became very chilled and if at all stiff refused to go through the chute properly.

Derrick Tower and Brick Hoist

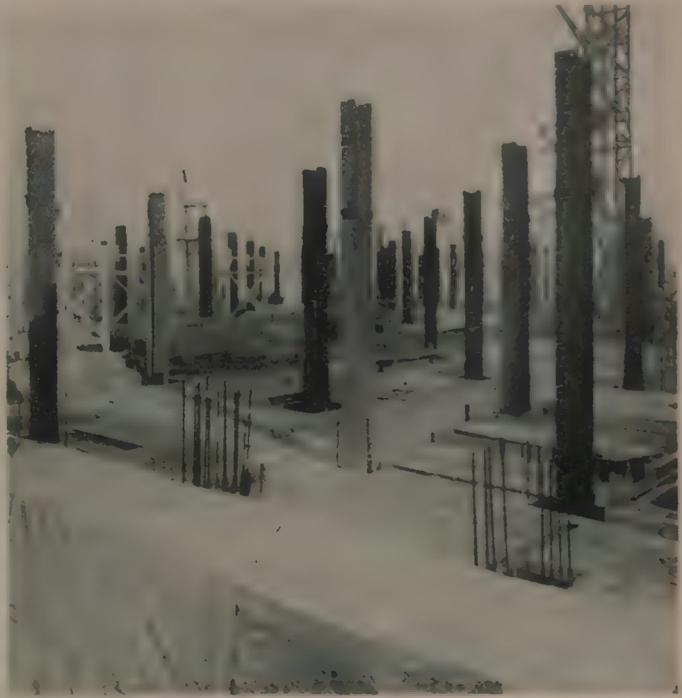
Timber, forms, brick, steel, etc., are all handled on the Alice Street side by a brick hoist and a derrick tower. The derrick tower which carries a stiff leg on its upper platform is also provided with a cage operated by a hoisting engine. Although this tower is not constructed of heavy timbers, due to the method of framing, it has proved stable under heavy loads, often amounting to a 7-ton steel column core. The brick hoist is of the balanced double-platform type. Small stiff legs and hand-operated builders' hoists complete the complement of handling apparatus. There is a portable electric-driven woodworking outfit which frames all the formwork on the job.

The foundation piers are 4 ft. square, tapering into spread mattresses 16 ft. square by 4 ft. high, to distribute the load. They rest on firm clay close to rock. The excavation for the piers was done by hand labor. A steam shovel performed most of the bulk excavation.

Columns are Steel Centered

The columns of the first eight storeys are steel-cored to keep the diameters to a minimum. The cores are of heavy Bethlehem sections and were erected in two-storey lengths by gin poles and derricks. The steel is designed to carry the entire load. It is fireproofed with concrete, reinforced with expanded metal and longitudinal steel and moulded to produce circular columns with flaring capitals. Riveted lug angles serve to transmit the slab loads into the cores. A total of 1,500 tons of structural steel is used altogether. The columns of the upper four storeys are of concrete without cores, reinforced with spiral and longitudinal steel.

The rough slabs vary in thickness from 7½ ins. to 11½ ins., depending on the designed live load, which ranges from 150 lbs. per sq. ft. to 350 lbs. per sq. ft. The finish floors on the first and second floors are 1½ in. cement; on the remaining floors 1 in. rough concrete and 1¼ in. maple on 2 x 4 in. sleepers. The drop heads measure: second floor, 7½ in.; third floor, 6 in.; remaining floors, 5 in.


The columns are steel cored, the steel taking the entire load. The canvas curtains at the bottom of the illustration protect concrete during cold weather.

Successful Winter Operations

A great deal of the work was performed during the severe weather of the past winter without any mishaps. During the cold weather the newly poured concrete in the structure was protected by tarpaulins

(Continued on page 522)

Prolonged Flat Slab Tests

Results of Experiments with Heavy Loads Over a Year Period Modify Existing Ideas Relative to Stresses

As few results of long time tests on reinforced-concrete buildings under heavy load have hitherto been reported, the conclusions derived as a result of such experiments on a building in Chicago are of interest. In consequence of these, new ideas relative to stresses in such buildings have been developed. Before the present Chicago flat-slab ruling came into force, each designer was required to satisfy the building department that the design was ample and the tests herein recorded were developed to meet this requirement. Mr. A. R. Lord, consulting engineer, of Chicago, carried out these tests on the Excelsior Motor Company's building, a six-storey structure measuring 673 ft. long by 80 to 138 ft. wide, constructed on the four-way reinforced-concrete flat slab system.

The main points brought out by Mr. Lord's tests are that stresses in the steel during the last four months of the test show practically no change, concrete deformations show progressive increase, the average increase being much more marked in the first five months than in the last seven, and that a shifting of the resisting moment occurs during the first six months, the stresses adjoining the columns decreasing and those at the center increasing, with an increase in the total moment, which averaged 10 per cent. for the first eight months, with no increase thereafter. Both steel and concrete stresses at the end of the year were less than were anticipated under the Chicago ruling governing flat slab design, and were also less than what previous extensometer tests had led one to expect.

Details of the Test Slab

The tests, which extended over a period of slightly more than a year, were applied to an exterior panel on the sixth floor of the building mentioned. The columns on this floor were the smallest and the effective span was the greatest. The panel measured 25 ft. by 26 ft. A service wing containing the elevators, toilets and washrooms for the building projected from the panel immediately adjoining the test panel. The slab reinforcement was of the four-way type. One-third of the slab rods in each direct band were carried through at the column and lapped without being bent up to take tension. All the diagonal bars were bent up. The slab was designed to be 9½ ins. thick, but actually measured a uniform 10 inches in thickness practically throughout the building. The slab steel at the column was not raised to take advantage of this increased thickness, however. The interior drops were 9 ft. x 9 ft. at their lower surface and 6 ins. thick, with the edges beveled to 10 ft. 6 ins. x 10 ft. 6 ins. at the bottom of slab. The wall drops were of corresponding size, but only 4 inches thick. The exterior walls were of concrete 9 inches thick and 3 feet high above the floor. The wall columns were 6 ft. 6 ins. wide by 1 ft. 6 ins. thick at the centre. They were reinforced with sixteen ¾-inch diameter rods 14 ft. 6 ins. long and tied at intervals of 9 ins. with ¼-inch wire. The interior columns were reinforced by spiral and longitudinal steel. All concrete was of a 1:2:4 mixture. The designed live load was 150 lbs. per sq. ft. uniformly distributed.

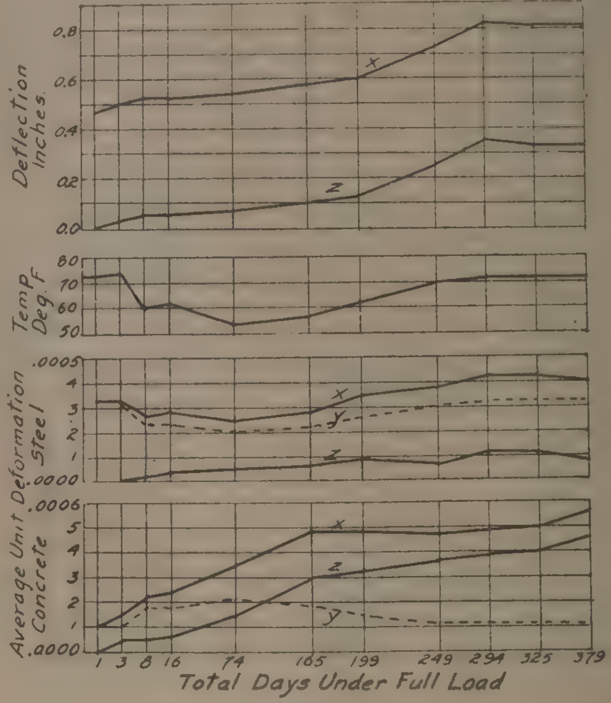
Test Extended Over a Year

At the suggestion of Mr. Lord, the test load was to be twice the designed dead and live load, required to remain in place one full year. The ordinary extensometer test was first made in the usual manner, and forty-four gauge lines of representative character, and showing the greatest stresses of their kind and location, were selected for the measurements, extending over a period slightly exceeding one year.

The first load was bank sand to an average depth of 22 inches, giving about 160 lbs. per square foot load. The next day, the depth was increased to 38 inches, equivalent to about 300 lbs. per square foot. After two days this was again increased to an average depth of 57 inches. This final load was about 450 lbs. per square foot. No part of the sixth floor for several panels around the test load was used during the year except for light trucking. The effect of load on adjacent panels is therefore believed not to be involved in the test.

Variation of Deflection

The deflection readings as indicated in the curves herewith, showed that the deflection at the centre of the panel increased from 0.48 in. after 24 hours' application of load to 0.8 in. after the load had been in place a year, thus denoting a general tendency for the deflection to increase at all times during the year. It was also noted that there was a general tendency for the deflection to decrease as the temperature dropped and to increase as the temperature rose. In the final three months of practically constant temperature the deflection remained nearly constant.



Curves showing results of flat slab tests.

In a slab such as this which is but a part of a large unit, the temperature changes will not take place freely. In interpreting measured deformations, therefore, the significant figure is not the actual change in unit deformation, but the difference between the actual change and the change which would have occurred had the slab been free to contract or expand. The actual change in stress is given by this difference. In the diagram, curves X are the actual deformation curves, and the curves Y apply to the unit deformations that would have occurred had the slab been free to contract or expand. The curves marked Z represent the difference between the X curves and the Y curves and measure the change in actual stress, neglecting changes in the modulus of elasticity.

General Conclusions

As a result of these long time, heavy load tests, Mr. Lord draws the following general conclusions:

1. The stresses in the steel show practically no change during the last four months of the test.

2. The concrete deformation shows progressive increase during the year. The average increase was much more marked in the first five months than in the last seven. This increase in the average compressive deformation is in accord with experiment on cylinders under laboratory conditions.

3. There occurred a shifting of a portion of the moment during the first six months of the test, stresses adjoining the columns decreasing, while those at the centre increased. This action must be considered in establishing design co-efficients.

4. The increase in the total moment, negative and positive, figured from the steel stresses, was relatively small, apparently amounting to considerably less than 10 per cent. for the year, with no increase in the last four months.

5. Comparison of the data of this test with that secured by Professors Fuller and Moore (1916 Proceedings Am. Concrete Inst.) leads to the conclusions that the actual maximum compressive stresses at the centre of the panel were not in excess of 350 lbs per square inch at the full test load.

Stresses Less Than Expected

6. Both concrete and steel stresses at the end of the year appear to be materially less than those to be expected under the Chicago ruling governing the design of flat slabs.

7. This test, taken together with other time tests of concrete in compression, would indicate that the reported values of the compression in the concrete in previous extensometer tests of flat-slab buildings are somewhat in excess of the true stresses actually present. This applies especially to the final readings when the full load has been in place for twenty-four hours.

8. Further tests of this nature would seem to promise a material addition to our understanding of the deportment of reinforced-concrete structures under load. Such tests should serve to reduce the factor of ignorance and make possible more economical design in those materials. The "Straight Line Theory" of reinforced concrete is clearly unapplicable to this test even with the load stresses present in the concrete and steel.

Department of Mines is Determining Road-Making Value of Canadian Rocks

THE Dominion Government, through the Department of Mines, has been engaged in examining occurrences of stone and gravel available for road construction since the summer of 1914. These surveys, which have been undertaken in the eastern half of Canada, have had as their object the determination of the road-making values of these rocks. Road-making will be such an important factor in the future development of this country that such investigations will prove of material benefit. Methods and results of such analyses were recently described by Mr. L. Reinecke, of the Canadian Geological Survey, in a paper read before the Canadian and International Good Roads Congress. Notes from this paper are made below:

Up to the present surveys have been confined to the Provinces of Ontario, Quebec, and New Brunswick. Prospecting for first-class stone has been undertaken along certain navigable waterways, but most of the work has consisted of mapping and determining the quality of all deposits of bedrock, glacial stone, and gravel, within hauling distance of certain highway routes and, in certain cases, over large areas.

Areal surveys have been undertaken near St. John and Moncton, New Brunswick; in Two Mountains and Soulanges Counties, Quebec; in Kent and Essex Counties, and in part of Carleton County, Ontario. Belts of country adjoining 270 miles of the 560-mile length of the Windsor-Toronto-Montreal highway and 150 miles of the 175-mile length of the Prescott-Ottawa-Montreal highway have been examined and mapped.

Three Classes of Materials

Three classes of road material—bedrock, boulder deposits, and gravel—are encountered in this work, and each has its own problems.

A certain amount of general information is gathered regarding nearly all bedrock occurrences, but our main concern is to first classify the bedrock according to its road-making value, and then to study the different classes to find the causes of variation in strength and to determine the distinguishing marks of good stone. Knowing these, the field man is enabled to classify the many occurrences of bedrock that cannot be tested.

The route survey along the north shore of Ottawa River, between Hull and Montreal, will serve as an example of the information obtained regarding bedrock. In this instance areas of bedrock lying within two miles of the road were mapped and numbered. In the report detailed information regarding the stone is given under numbers corresponding to numbered areas on the accompanying map.

Determination of Relative Value

In order to discover the relative quality of the stone available in the area the rocks were first divided into geological formation and the formations into rock types. Rocks made of the same mineral particles, under the same conditions, at about the same time, and subjected since then to the same earth stresses, are, under this system, grouped together. Certain of the groups, from the previous experience of road-builders with material of a similar kind, can be at once rejected. In this area, after rejecting certain soft, coarse crystalline limestones, friable sandstones, and much altered gneiss as unfit for road work, there remained six classes of stone. Several samples of each of these were then tested in the laboratory, and their behavior under the action of traffic studied wherever that was possible. Upon the results of the tests, modified by data regarding the uniformity of the product obtainable and by other considerations, decisions regarding the usefulness of the rock types in road surfaces were based.

Laboratory and Service Tests

Of the five standard tests performed in the laboratory the most important are those of per cent. of wear or abrasion, toughness, and cementing value. The standard methods of making the tests simulate the action of traffic on fragments of broken stone in a roadbed. Loads passing over a broken stone road abrade the fragments at the surface, and cause slight movement and internal abrasion between the fragments in the road mass. The blows of horses' hoofs and of swiftly-moving vehicles bouncing from small obstructions on the surface test the toughness of the stone. The pressure of loads and the action of rain water cause the upper surface to cement into a solid mass, and this bond is, in turn, destroyed by winds on a dry road surface, and by the frictional pull and elastic rebound of rubber tires.

Laboratory tests are arbitrary, but they are uniform and standard, and, therefore, afford a means for comparing rocks. A fair comparison between two kinds of stone under actual service conditions can scarcely be obtained unless the roads on which they are used are constructed under somewhat similar conditions and have had to bear about the same kind and amount of traffic. Where road-building has just begun such a means of comparing two types of stone are in most instances not available. The comparison of laboratory and service tests has enabled engineers to specify certain laboratory values for stone to be used under certain conditions of traffic and on certain road surfaces. Thus the lowest allowable toughness for stone in the surface of water-bound macadam is placed at 6, the highest allowable per cent. of wear at 5. For moderately heavy traffic the stone should have a toughness of from 10 to 18, and for traffic of 250 vehicles per day and over, over 18. For bituminous macadam, which is generally used only when the traffic is fairly heavy, a minimum toughness of 13 and a maximum wear of 3.7 is called for.

Ottawa-Prescott Survey

When it is possible to separate geological formations into areas, as in the case of part of the Ottawa-Prescott survey, the outcrops within whole areas may, in many cases, be at once rejected. The formations in this neighborhood consist of bedded sediments, dolomites, limestones, shales, and sandstones, and the stone worth considering occurs in four formations. A number of samples were tested from each, and compared in the manner indicated above for the Hull-Montreal route. It was found that certain dolomites and calcareous sandstones of the Beekmantown formation gave uniformly better results than the others. They were, therefore, recommended as the best available local material. Service tests substantiate this conclusion. Where dolomite is used on the roads near Ottawa it has stood up well in certain instances under traffic up to about 100 vehicles per day. The limestones of the Chazy, Black River, and Trenton formations, on the other hand, which are commonly used near and in Ottawa, usually wear to dust and holes rapidly under similar conditions of traffic.

Causes of Differences in Value

The method of laboratory tests has the disadvantage that usually only one out of five or ten of the deposits examined in the field can be tested, and the sample tested is only a small portion of a large deposit. More frequent and close sampling is not often practicable, and the results of the tests are in many cases not available until after the field work is done. For efficient work, therefore, it is necessary for the field man to know the distinguishing marks of a good road stone, and the best way to arrive at them is to discover the causes of the difference in strength and cementing value of stone. For this purpose both the microscope and chemical analyses are used. Careful and extensive comparison of the microscopic texture with the results of laboratory tests upon road stones have been carried on at the Office of Public Roads at Washington. The results of this work have furnished a basis for classifying the main rock classes in regard to their road-building qualities. But just as men of the same race and age differ greatly in their powers of endurance and their capacities for absorbing food, for instance, so rocks of the same class vary in strength and cementing value. The characteristics of the rocks in each particular field must, therefore, be studied in order to do effective work.

Boulder Deposits or Fieldstone

Fieldstone or glacial boulders are found piled in fences and heaps in cleared farming country and form an important source of road material. The fences are grouped into numbered areas on the map and the information regarding them compiled in a table. The table gives the yardage present in any area and the average composition of the boulder aggregates. The composition is an average of estimates of composition made for practically every fence; the yardage is measured, fence by fence, and compiled for the area. Here again the problem is to distinguish between boulder aggregates that will make good road surfaces and those that will not. The aggregates are, except in rare instances, made up of a number of rocks varying in character. They have been grouped in this area into "hard," "limestone," and "soft," the hard being made up of rock classes considered of good, the limestone of intermediate, and the soft stone of poor wearing quality. The presumption is that the durability of the stone in a road surface depends on the relative amounts of these three classes present in the aggregate.

In the case of the Ottawa-Prescott route area there is a relation between the amount of soft boulders and the percentage of wear, but this relation, based on the same classification, does not hold in other districts, and in later field work in other areas boulder aggregates have been regrouped into "durable," "intermediate," and "soft," according to the average percentage of wear of the class of rock to which they belong, the limiting maximum per cent. of wear for intermediate being placed at 5.6 and for durable at 3.9. Durable and intermediate include, roughly, stone that would satisfy the requirements of bituminous and water-bound macadam respectively.

Standards for Judging in the Field

Experiments are being carried on in the laboratory of the Department of Mines to determine the per cent.

of wear of aggregates consisting of various proportions of durable, intermediate, and soft rocks, as defined above. The idea is to find standards by which the durability of a boulder aggregate may be judged in the field. It is necessary for the field man to have some idea of the relative durability of the bedrock from which these boulders come, before he can use this classification to advantage in the field. Because of the many miles of road that will have to be built of crushed fieldstone in Canada, it would seem that results along this line will be of value.

Gravel

Gravel is perhaps the most difficult of the deposits with which we have to deal. Gravel areas are mapped in the field and numbered in the same way as the bedrock and fieldstone areas, the numbers differing in color for each of the three kinds. Information regarding the gravels is compiled in two tables, one describing the character of the gravel, the other giving information regarding its exploitation and uses. In the table dealing with the character of the deposits, depth of weathering, texture, or grading of sizes, impurities, and pebble composition are given. The relative amounts of boulders, gravel, and sand as given are correct only for the pits examined. Gravel deposits vary so much throughout their extent that an average of the texture cannot be obtained except by sinking test pits or auger holes. Except in the case of the silt content, no field method has been devised as yet for estimating the percentage of impurities present. There is great need here for laboratory and field work, because of the importance of the influence of the impurities and fine silt content upon the strength of concrete and in sheet asphalt work.

Relation Between Pebble Composition and Wear

The gravels are tested in the laboratory for abrasion and cementing value, and a mechanical analysis is made to determine the proportions of the different sizes present below 3 inches. An attempt has been made to trace a relationship between pebble composition and laboratory tests upon wear. A broad relation was established between the percentage of soft pebbles in the gravel and the percentage of wear, but it is by no means a close one, and since the work was done we have changed our system of pebble classification in the endeavor to evolve some scheme whereby an estimate of pebble composition would enable the field man to predict more closely the durability of the gravel he was examining. It should be stated that the present standard methods for making the abrasion test for gravel are not wholly satisfactory, and the wear of the gravels on roads has in certain instances confirmed the conclusions drawn from their pebble composition rather than from the results of laboratory tests.

As this outline indicates, many of the methods used for determining the value of road materials are far from satisfactory, and we believe that improvements may be effected by close co-operation both with those engaged in road-building and with men who are testing stone and gravel in other laboratories.

Summary

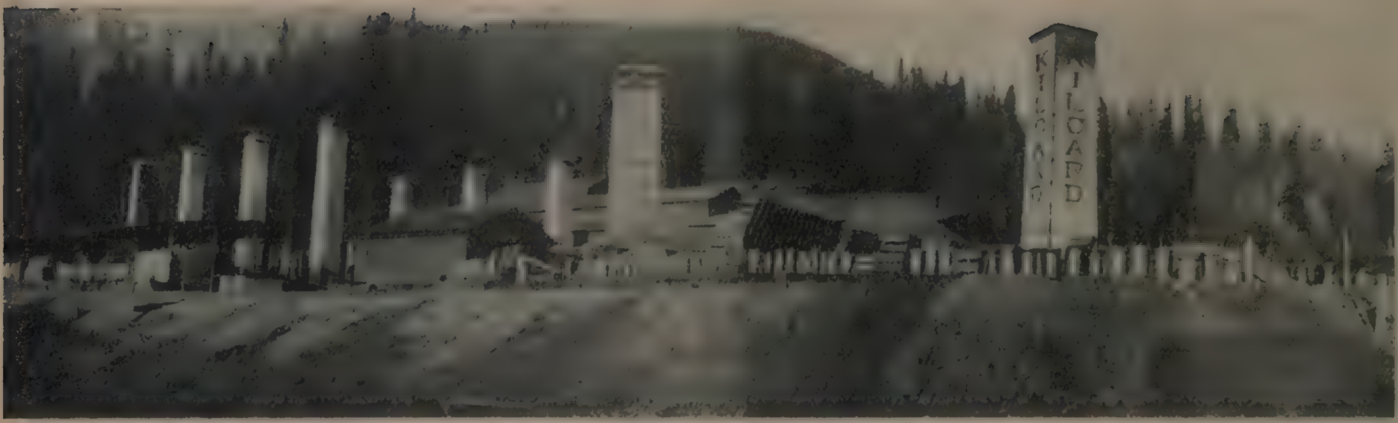
In order to determine the road-making values of the rocks in a certain district they are first divided into formations and then into rock types; their average values and the variation in strength and cementing value of each type is obtained by laboratory tests on a number of samples, and the results thus obtained are compared with actual service tests in the roads wherever possible. Laboratory studies with the miscroscope and by chemical analyses are then undertaken to discover the cause of such variations in order to furnish data which will enable the field man to distinguish a good stone from a poor one in the outcrop. With a working knowledge of the strength of the bedrock in a district, an attempt is made to devise a classification of the kinds of boulders in the fieldstone deposits in such a way that their composition expressed in percentages of durable, intermediate, and soft boulders will bear a direct relation to their percentage of wear, as determined in the laboratory, and to their durability under traffic conditions. The pebbles in the gravels of the district are classified in a manner that will bring about the same result. The impurities present and the texture or grading of the gravels are studied in order to furnish advanced data as to their probable value in concrete and sheet asphalt work.

Contract Let for Western Convent

THE contract has recently been let to the Poole Construction Company, of Regina, Sask., for the construction of a $100,000 convent at Gravelbourg, Sask., for Les Religiouses de Jesus Marie. The building will be a four-storey and basement structure, 150 ft. x 53 ft. in plan, and will be of solid brick construction faced with cut stone. The interior finishings are to be of hand-dressed fir, while the vestibule will be finished in pannelled oak. The plans call for a handsome entrance of cut stone. The most up-to-date plumbing and heating systems will be installed, provision being made for a double unit of tubular boilers for steam-heating. The basement will contain a laundry, trunk and store room, machinery and boiler rooms, and two large recreation rooms for boys and girls. On the ground floor will be a boarders' refectory, 62 x 28 ft., also a number of class rooms and bedrooms, a recreation room, kitchen and pantry. The first floor includes a large parlor and reception room, quarters for the sister superior of the institution, the bursar's offices and a number of bedrooms and class rooms. A chapel will be located on the second floor, also accommodation for the sick, the plans showing a large infirmary and pharmacy, in addition to five class rooms. On the top floor there will be two large dormitories, one of which is 72 x 20 ft., the other measuring 50 x 36 ft. The music room, containing eight compartments, is also located on this floor, as well as several bedrooms and eight bathrooms.

Increase in Business

Canadian Explosives, Limited, owners of James Island, Gulf of Georgia, where a huge plant for the manufacture of various grades of powders and other explosives has been created within the past three years—has experienced a tremendous increase of business as a result of the war. The management now find it necessary to still further extend the plant by the addition of a separate department to take care of the B. C. orders for powders, which have more than trebled in volume as a result of the marked activity in mining operations. In the neighborhood of 600 men are now employed by the company, and this number will be increased when the new department is added.



General view Kilgard Fire Clay Co. Plant, Sumas, B.C. Railway track in foreground not shown.

British Columbia Clay Plants Have Great Variety of High Grade Materials

PROBABLY few readers of the Contract Record are aware that the Coast section of British Columbia can boast of possessing two of the most modern and best equipped plants for the manufacture of brick, sewer pipe and general clay products to be found in the Western portion of the Dominion. One of these—the works of the Clayburn Company, Limited, at Clayburn, Fraser Valley, was described at great length in these columns some five or six years ago; we now perform a similar service for the younger but equally up-to-date concern.

Showing clay delivery by gravity train.

The plant of the Kilgard Fire Clay Company, Limited, was completed in 1913 at a cost of about $500,000, the moving spirit in its creation being J. C. Maclure, an energetic British Columbian, who a number of years ago assisted in organizing the Clayburn Company. The new plant was equipped to keep pace with the continued rapid progress then so confidently expected by all, but unfortunately the collapse of real estate speculation in the latter part of 1913, followed by the outbreak of the war in midsummer of 1914, led to the complete collapse of building and nearly all sewerage activity throughout the province. Naturally the company in the interval has operated only intermittently, but General Manager Maclure is now looking forward to a resumption of activity, for which the plant is being prepared.

The Kilgard clays occur in the sandstone formation of Sumas Mountain, on the southwest quarter of Sec. 29 and southeast quarter of Sec. 30, township 19, New Westminster district, and the works site from the adjoining Sumas Indian Reserve connects the whole with the Great Northern Railway (V.V. & E. branch). In all, the company own 320 acres, on which there are exposed in the face of Sumas Mountain fifteen seams of clay ranging in quality from red burning shales to highest grade fire clay. These clays adjoin the Clayburn measures, of which they are a continuation, the Clayburn works being located on the Matsqui Prairie

Mine end of gravity train and clay bunkers.

side of the mountain, and Kilgard on Sumas Prairie side.

The main factory building is 130 ft. x 270 ft., three and one-half storeys (including boiler house); construction, frame on concrete foundations. There are ample stock sheds, large boarding and bunk house, dwellings for married employees, etc. The ground floor of main building is of concrete, with steam pipes beneath. On this floor all fire brick shapes are made and dried, while the two upper floors are also piped for the steam drying of sewer pipe, etc.

Fire brick and face pipe are burned in four rectangular kilns, each 15 ft. x 75 ft. inside dimensions (oil equipped), and sewer pipe in six 35 ft. diameter round kilns, all down draft.

The clay mines have been developed according to most approved methods. All tunnels are well timbered and electric lighted. The mines are connected with the factory by a series of chutes and gravity tram line serving all levels from No. 0 to No. 8 seams. At the works the raw clay is dumped into a hopper and fed by gravity to a large size Champion rock crusher and conveyed in crushed rock form to the main bunkers. From the bunkers the crushed clay is fed by gravity to the dry pans, elevated to the screens and delivered in powdered form to the ground clay hoppers, passing from them to the wet pans for sewer pipe or fire brick, or to the dry press for face brick, as the case may be. There is also a separate clay hopper for holding ground fire clay, from which it can conveniently be sacked or shipped in bulk.

Both steam and electric power is used. The boiler house contains two 6 ft. x 18 ft. boilers, each 150 h.p., which furnish steam to one 16 in. x 20 in. Wheland engine. Electricity is supplied by the Western Canada Power Company, Limited, Stave Lake, and is used for all motive power except the steam sewer pipe press and heating purposes, driving one 150 h.p. motor, eight 50 h.p. motors and five 15 h.p. motors. The other machinery is as follows:

Three 9 ft. "Berg" dry pans; three 9 ft. "Berg" wet pans.

One 44 in. x 60 in. x 21 in. red Stevenson sewer pipe press, with full equipment and dies for making pipe in all sizes from 4 in. to 30 in., as well as dies for many other purposes.

One "Berg" dry press for making face brick or fire brick—four moulds, with a capacity of 20,000 brick per day of 10 hours.

"Premier" Auger brick machine, with Holloware dies and 80 drier cars.

Five hand re-presses for making fire brick, with full equipment of moulds.

The full list of products turned out by the Kilgard Company comprises vitrified salt glazed sewer pipe, sewer lining blocks, flue lining, partition tile, fire brick, fire blocks, face brick—cream, buff, gray and red shades. Material for paving brick of high grade is present in quantity, but has not yet been opened up. In the case of the lines mentioned the experimental stage has long since been passed, the manufactures being up to the most exacting standard of a critical market.

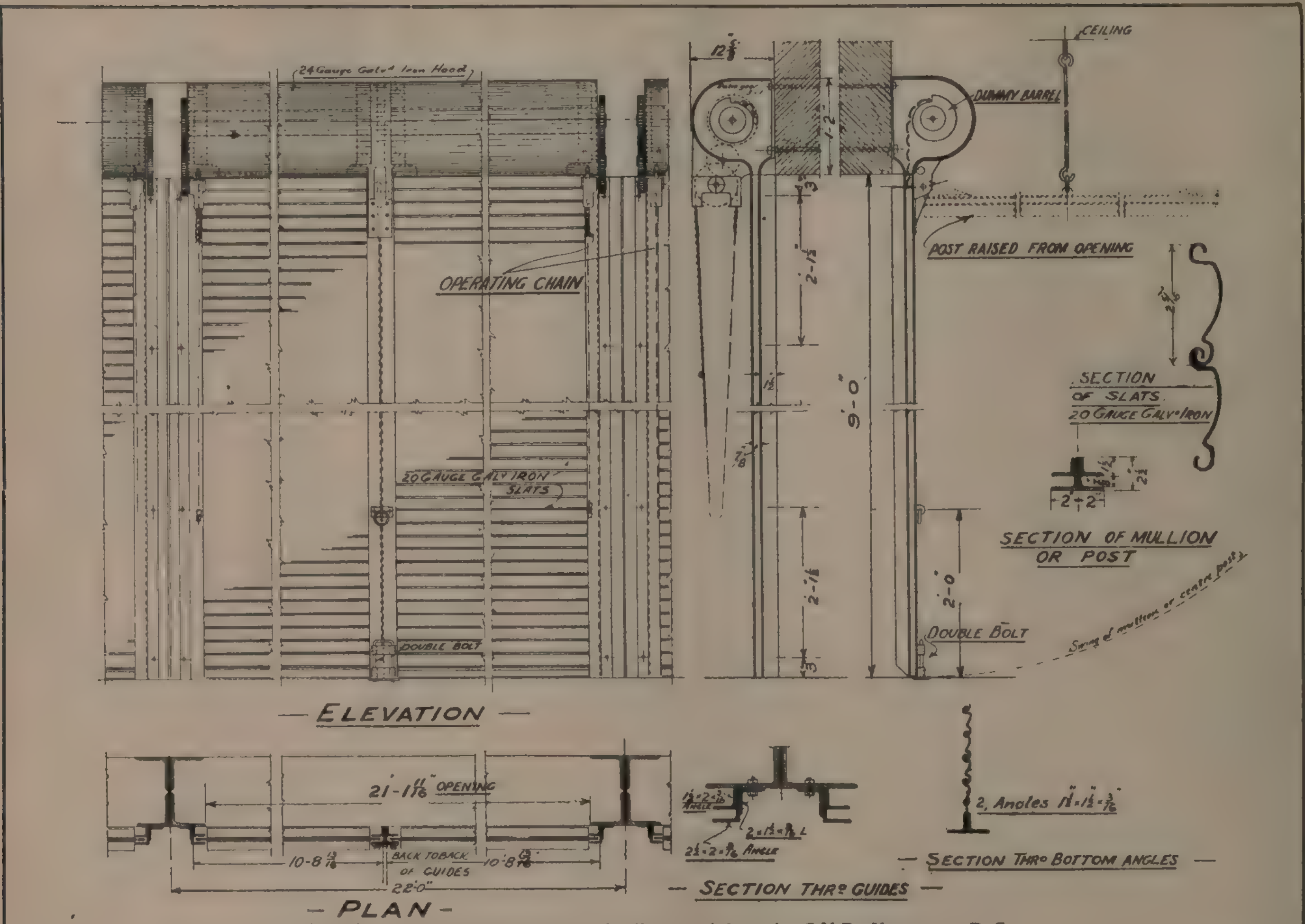
Large Rolling Steel Door Installation

THE photograph reproduced herewith illustrates a noteworthy equipment of rolling steel shutters recently installed in the new freight sheds of the Great Northern Railway at Vancouver, B.C. The installation comprises a total of one hundred and thirty-eight doors of a rolling steel type. They are of a design that facilitates the handling of bulky freight, a special feature being a hinged centre pilaster to each pair of doors, which makes allowance for a clear double door opening, if desired, so that box cars have not to be accurately spotted. Particular note should be taken of the fact that these doors do not interfere with the clear floor space in opening and closing same. The shutters are fireproof, and will protect the contents of the freight shed from external fires, and also prevent internal fires from spreading to other buildings. This is a feature of importance. Installations of this type are very suitable for docks and railway freight sheds.

The details of the shutters are shown in the accompanying drawing, while the photograph indicates the general appearance and arrangement of the installation from the inside. They are arranged along the long side of the sheds adjoining the sidings. On one side of the sheds single door openings are provided, while on the other side provision is made for obtaining a double width opening by having a swinging centre post, which is raised and hooked to the ceiling after the doors are rolled up. If desired, the centre post may be bolted to the floor, in which case only a single doorway is provided. This swinging post feature is particularly noteworthy—openings of extreme width can be fully covered by means of a series of shutters with moving posts between them.

Shutters are chain-operated, non-automatic, built up of patent interlocking slats made of No. 20 galvanized iron. A section of the slats is shown in the drawing. The shutter guides are composed of angles riveted together, as shown, and bolted to the H-section plate and angle columns. The hood is made of 24-gauge galvanized iron and the shutter is counterbalanced with heavy springs inside the shutter rollers. The chains operate through gearing having a ratio of

Showing steel shutters from interior. Note pivoted mullions.



Plan, elevation and general details of rolling steel doors for C.N.R., Vancouver, B. C.

3:1. The centre mullion guides, composed of riveted angles, swing on a hinge at the base of the hood and hook to the ceiling when raised. A double bolt fastens it to the floor when in its vertical position. The clear opening width, when the mullion is swung up, is 21 ft. 2 in. Each door measures 10 ft. 9 in., back to back of guides. The clear height is 9 ft. from floor to base of lintel.

These shutters were supplied by the A. B. Ormsby Company, Ltd., of Toronto. The two buildings, composing the freight depot, were designed by F. L. Townley and erected by Grant, Smith & McDonnell, Ltd., general contractors.

Two Well-Arranged Mixing and Storage Plants Build Twelve-Storey Factory

(Continued from page 515)

around the building, straw over the top of the concrete and salamanders, kept fired until proper setting had taken place. Steam pipes throughout the aggregate bins with hot water produced warm concrete. With these precautions no difficulty was experienced in the cold weather work. Night work was carried out during the winter to keep the pouring continuous.

The form work was of the conventional type with metal column and capital forms and wood slab centers. The latter were framed up in panels to facilitate their re-use.

The concrete skeleton is being faced with brick, the bricklaying following the pouring as closely as possible. Patent safety scaffolds are used, which may be adjusted without interfering either with the work or the workmen. Steel sash and doors are being installed. The equipment will include six elevators and one plunger. The four stairways are of concrete with Mason safety treads.

The building was designed by Wm. Steele & Sons, architects and engineers, and is being constructed by the Raymond Construction Company, general contractors. Mr. Sinclair is the superintendent for the contractors.

The Tennessee State Highway Department has announced an examination for assistant highway engineers to be held in Nashville. This examination is in conformity with the provision of the recent law that requires employees of the department to pass a satisfactory examination before the dean of engineering of the University of Tennessee, the state geologist and the state highway engineer.

Narrow strips of concrete about one foot wide have been laid alongside the curb on certain Chicago streets where the sidewalks are not adjacent to the roadway. These are connected across the lawns to the main sidewalks by narrow transverse strips of concrete, thus forming neat paths for the convenience of residents wishing to go to automobiles waiting at the curb between street corners.

Street Widening to Meet Traffic Demands

Difficult Problem to Provide for Increasing Street Congestion—Simpler to Look to the Future — Examples of Many Methods

By Nelson P. Lewis[*]

ONE of the most difficult problems confronting towns and cities is the provision for the greatly increased street traffic which has developed during the past few years, especially since the introduction of motor vehicles. The first step in such relief is obviously that of traffic regulation, the object of which has been well defined as "the passing by artificial regulation through existing streets of inadequate capacity, with safety to both vehicles and pedestrians, of a larger volume of traffic than the streets would accommodate were the movement of both left uncontrolled."

A great deal has been accomplished by intelligent police regulation, but the volume of traffic increases so rapidly that further steps soon become necessary, such as the cutting through of new or the widening of existing streets in order to convert them into important traffic arteries. It is this last method of improving traffic facilities which is the subject of this article. There are two separate kinds of problems involved:

I.—The widening of streets already congested; and,

II.—The widening of streets which are in use or which are only laid out upon the city plan where there is no traffic congestion at the present time, but where future congestion should be avoided.

The Problem Applied to Streets Already Congested

I.—An increase in the traffic capacity of streets already congested may be accomplished in several different ways:

(a) By setting back the curb and increasing the roadway width and removing encroachments beyond the building lines in order to compensate for the narrower sidewalks, no change being made in the actual lines of the street. This is a simple method which will involve no expense to the public except that of the adjustment of the curb and pavement, but will require those who have been making use of a part of the public street for their own profit and convenience to remove encroachments at their own expense.

(b) An actual street widening by cutting off portions of the lots on one or both sides of the street, the improvement being carried out at a single step. This involves large expense, but will secure the desired results at once.

(c) A progressive widening by the establishment of new street lines, with the requirement that all new buildings erected shall be set back to the new lines, and that all buildings which may be substantially altered, involving the building of new fronts, shall at the time of such alteration be set back to the new lines. This is a much more economical method, but the time required is often very long and the street during this progressive widening will present a very ragged and unsightly appearance.

(d) The widening of the roadway by appropriating practically all of the sidewalk space and the placing of the sidewalks in arcades back of the building line, easements on private property being acquired for this purpose. Such a plan will involve considerable expense, and, unless there is some effective control of the architectural treatment of the building fronts, including the design and spacing of the supporting columns and uniformity in the height of the arcade, the results are likely to be very unsatisfactory, although with such control the streets so treated would gain in interest and picturesqueness.

To Avoid Future Congestion

II.—The avoidance of future congestion by the provision of adequate thoroughfares is, in many respects, a much simpler problem, although it is impossible to predict with any degree of certainty which streets may be called upon to accommodate exceptionally heavy traffic. Two methods of treatment may be resorted to:

(a) Streets of ample width can be provided at certain intervals or where their grades and their positions with respect to the general plan will render a concentration of traffic probable. The initial improvement of the roadways of such streets may be at much less than their ultimate width, the sidewalk space being left in grass plots or planted with shrubbery until the time comes when space must be added to the roadways.

(b) Setback lines or building lines can be established in addition to the regular street lines, no buildings to be erected on this space, although it may be used for the beneficial enjoyment of the owner of the abutting property. In this case the city would acquire the space between the street lines for a public street and acquire an easement of light and air for the spaces between the street lines and the building lines, which spaces could be converted to street use when greater roadway capacity is needed. This plan has the advantage of insuring more generous light and air space and at the same time will permit an initial development involving less burden upon the abutting property for land taken and for street pavement.

Examples

The several methods of providing traffic thoroughfares can best be illustrated by a few concrete examples and, while these examples are taken from a few of the large cities, some of them relate to suburban or partly developed sections, so that the methods which have been followed will be applicable to cities and towns of much smaller size.

I. (a) New York affords some notable instances of roadway widening during the last few years. Perhaps the most conspicuous of these is that affecting Fifth Avenue. This street was laid out and acquired at a width of 100 feet, and was subdivided into a roadway of 40 feet and sidewalks each 30 feet wide. One-half of the sidewalk spaces had for many years been appropriated to private use. Many costly buildings had been erected, the entrances, steps, and even supporting columns of which were within the street lines. In many instances fences had even been placed 15 feet beyond the building lines, and in the spaces enclosed by them there were sunken gardens and ornamental planting, which added to the attractive appearance of the street.

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As the abutting property was gradually converted from residential to business use, and as the traffic increased the roadway became inadequate, and it was decided that it should be increased from 40 to 55 feet. In order to compensate for the space thus taken from the sidewalks the removal of all encroachments beyond the street line was directed, although, in order to prevent the disfigurement of some very important and attractive buildings, it was agreed that owners who should, before a fixed date, remodel their buildings might retain such supporting columns or steps as would not encroach more than 2½ feet beyond the building line. The entire expense of these changes had to be borne by the abutting owners.

Where there are street railway tracks in the street the amount of the widening should, of course, be such as will accommodate one, two, or more lines of vehicular traffic outside the railway tracks on each side. In the case of a single track, 26 feet will accommodate one line of traffic outside of the surface cars, while two lines can be accommodated by a roadway 43 feet in width. In the case of a double track railroad a single line of traffic outside of the surface cars would require 36 feet and two lines of traffic about 53 feet.

Widening an Existing Street Is Expensive

I. (b) The widening of an existing street at a single operation is expensive, but occasionally it must be done. An example of such an undertaking is given.

Relief for the congested condition of Broadway, New York, was imperatively necessary when, in 1893, the municipal authorities decided that Elm Street, now known as Lafayette Street, parallel with and about 50 feet east of Broadway, should be widened. The old street was from 50 to 60 feet in width, and this was widened to 80 feet, and extended at the last-named width as an entirely new street for a distance of over 3,000 feet. The entire length of the new thoroughfare thus created was about 6,000 feet. The total cost for the acquisition of property was approximately $5,500,000, two-thirds of which was borne by the city at large and the remaining third was assessed upon an area of benefit about 3,000 feet in width and 19,000 feet in length, containing approximately 1,280 acres. Owing to the irregularity of the property lines, remnants were left along the sides of the street, which remained in an unsightly condition for many years, and some of which have not yet been incorporated with the adjoining property, thus permitting the erection of buildings which would be suitable for a street of this importance.

Establishing New Building Lines

I. (c) The method of establishing new building lines and progressively carrying out a widening has been used very infrequently on this continent, although it is quite a common practice in European cities. Probably the best examples are to be found in Philadelphia. A well-known instance is that of Chestnut Street, formerly 50 feet in width, which was widened to 60 feet on the city plan by an ordinance adopted in 1844. It formerly had a roadway 26 feet and sidewalks 12 feet wide, the additional width being added to the sidewalks, the roadway remaining unchanged. Recent traffic counts showed about 4,600 vehicles passing a given point on this street between 5 a.m. and 9 p.m. The ordinance provided that after the adoption of the new lines no new buildings should be erected or any buildings should be rebuilt or altered without being made to conform with the new lines. The improvement has been in progress for 33 years, and has been completed for the greater part of the distance. As buildings have been set back the owners have filed petitions for damages, and in general awards have been allowed for ground taken where the abutting lots were reduced to a depth of less than 100 feet, but where a 100-foot lot remained no awards have been allowed. Up to the present time the awards have reached a total of more than $500,000.

Placing Sidewalks in Arcades

I. (d) A few instances are to be found of increasing the traffic capacity of a street by converting one or both of the sidewalks into roadway and placing new sidewalks in arcades under the buildings. Philadelphia furnishes a notable example. Fifteenth Street, between Market Street and South Penn Square, has a width of 50 feet, with a roadway of 26 feet and sidewalks of 12 feet each. The curb on the east side was set back 11 feet, or within one foot of the street line, while a sidewalk 19 feet in width was provided back of the new curb line and extending 18 feet under the buildings. The arcade thus formed has been treated uniformly, the supporting piers are regularly spaced, and all of the same size, and the results of this treatment have been very satisfactory, the shops fronting on the arcade appearing to be desirable, and they probably command good rentals. The total length of this arcade is 335 feet, and the cost to the city in damages paid for the easements and the reduction of available floor space in the buildings amounted to $193,000.

It should be pointed out, however, that such treatment cannot be successful unless the arcades are of uniform height and unless the supporting columns and the facades of the buildings themselves are harmoniously designed.

Planning for Future Requirements

II. (a) Where the rapid development of a particular district may be reasonably expected, or where it is necessary to provide more adequate street capacity in order that traffic may be accommodated and suitable transit lines may be constructed within the streets at some time in the future and expensive widenings may be avoided, it is often necessary to lay out streets of generous width, following the lines of existing roads, which now serve as connections between centres of population, the importance of which will probably increase.

It may be difficult to convince the public that the provision of streets of this exceptional width years in advance of their actual need is at all necessary, especially where the cost of their acquisition is met wholly or in part by local assessment, and it is only by the exercise of somewhat arbitrary power by those possessed of vision that thoroughfares of these exceptional dimensions can be secured while the land is yet cheap and while there will be little or no damage to buildings.

Providing Setback Lines

II. (b) The plan of making future widenings possible and economical by the establishment of setback lines is relatively new in this country, although in some American cities there is a distinction between the street line and the building line. In most of our cities, however, these terms are considered to be synonymous. It may not be out of place to refer to the powers given to the Corporation of the City of Liverpool by an act of parliament passed in 1908, one year before the British Town Planning Act became a law. The city may require any land owner who proposes to develop his property to lay out streets of such width as it may prescribe, with the provision that compensation need be paid only in case a main thoroughfare is required to be more than 80 feet in width or any other street more than 36 feet wide. Power also is given to require buildings to be set back any distance from the street which the authorities may determine, with the proviso that, if this distance is more than one tenth the width of the street, compensation must be made. It will be seen that under this act, if a street is laid out at a width of 80 feet, the corporation may require setbacks which will give a width of 96 feet between buildings without any compensation to the owners of the property.

Expense of Relieving Congestion

A single illustration will be used to show the enormous expense involved in the correction of mistakes due to failure to provide traffic arteries of sufficient width to met future demands. This is the creation of the Strand-to-Holborn improvement in London. The need of a direct connection between Holborn and the Strand was appreciated at least as early as 1836, when a plan for a thoroughfare to serve this purpose was presented to the public authorities. It was then proposed to give it a width of 50 feet. In 1838, in 1847, in 1855, in 1883, in 1889, in 1892, in 1895, and in 1896 the project was revived, and on a number of occasions parliamentary authority was asked to carry it out. Nothing was actually accomplished until 1899, when such authority was finally given, the improvement was at once undertaken, and the new street was opened in 1905. Its estimated cost in its final form was more than $30,000,000, and the actual cost of the property taken was about $1,000,000 less than had been estimated. The years of agitation required to secure this much needed improvement and its enormous cost form as good an argument as can be presented to indicate the great importance of providing adequate traffic arteries without waiting for the need to become acute.

Factors Limiting the Production of Riveted Work

AFTER making time studies of a certain riveting gang which at that time consisted of four men—riveter, bucker, sticker and heater, certain factors were found to limit their production. In "The Water Tower," published by the Chicago Bridge & Iron Works, these factors are outlined as follows:

(1) Waiting for rivets. This in turn resulted from time waiting for heater to throw out rivets to the riveting gang and waiting for heater to get rivets from storage bins. On a certain job ¾ inch rivets were being driven. The job required about 1,200 rivets. After driving for five hours the ¾ inch by 3 inch at the rivet heater's bins were used up. Heater went over to the rivet storage bins and found there were no more ¾ inch by 3 rivets in stock. He came back and reported the fact to the riveter who in turn went to the foreman and told him that there were no more ¾ inch by 3 inch rivets on hand. He received orders to use ¾ inch by 2¾ inch or ¾ by 3¼ inch. In order to do this the riveter had to arrange for a smaller die or a larger die, depending upon the length which he found to work to the best advantage.

Considerable Time Lost

A glance at the time study sheet shows repeated instances of waiting for rivets, for example, after a piece of work had been finished and a new piece clamped in place, there appeared in the time study sheet "Waiting for rivets 2.5 minutes." Why did five men wait 2.5 minutes each? Simply because one boy did not put the rivets in the furnace at the right time. On another sheet in the time study sheet appears the item "Waiting for rivets 5 minutes." The rivet boy watched the riveting gang, turned column over and clamped it, instead of attending to his own business and seeing that rivets were ready to start driving as soon as material was clamped down. Five minutes elapsed between time the work was ready before the first rivet was pitched out. On riveting a certain post with lattice and cover plate, following is the analysis of the work done:

	Min.
Handling	2.7
Driving 39 rivets and taking out 29 bolts . .	2.5
Driving 114 rivets and taking out 24 bolts . .	11.5
Waiting for rivets....	14.7
Total 153 rivets in	36.9

This is at the rate of 249 rivets per hour. The schedule calls for 300 rivets per hour. If we deduct 14.7 minutes—waiting for rivets from 36.9 minutes, the result is 22.7 minutes actually spent in driving this post. This is at the rate of 405 rivets per hour. It is therefore evident that the only thing to do, in order that the gang shall make a handsome bonus is to teach the rivet boy to throw out the rivets at the proper time and save the time otherwise wasted in waiting for rivets. Experience proves that the rivet heater has more influence on limiting the production of work than any one factor.

(2) Trouble with dies: The tool steel used in dies will not stand up when driving at the rate of 250 to 300 rivets per hour. It was necessary for the riveter to have a can of water constantly at his side and to quench the dies after driving 20 or 30 rivets.

Fitters Slower than Riveters

(3) Work was not properly fitted up. The fact is, a great deal of it was rotten. The fitting gang could not fit up fast enough to keep the riveting gang going at top speed and the result was that they slighted their work and the material turned over to the riveters was not as it should be. More fitters and better fitters should have been used so that the work, when turned over to the riveting gang, would have been ready to be riveted. As it was, the holes did not match up and required drifting.

(4) The riveting gang had to take out their own bolts.

(5) The riveter could not find the special tools for various classes of work, because of the fact that he had no tool box in which to lock up his tools, with the result that everyone in the shop had access to his tools and if they wanted anything and his back was turned they would simply walk away with it and when he needed that particular tool again he had to go and appropriate it from some one else.

(6) The rivet heating furnace is located on a platform. This caused considerable loss of time in getting rivets and also prevented co-operation between the heater and the gang, because of the fact that the rivet boy could not always see the work and it was impossible for the riveter to talk to the boy and give him instructions regarding the work.

(7) There was insufficient space for the riveting gang to work in.

(8) Finished material was not taken away fast enough.

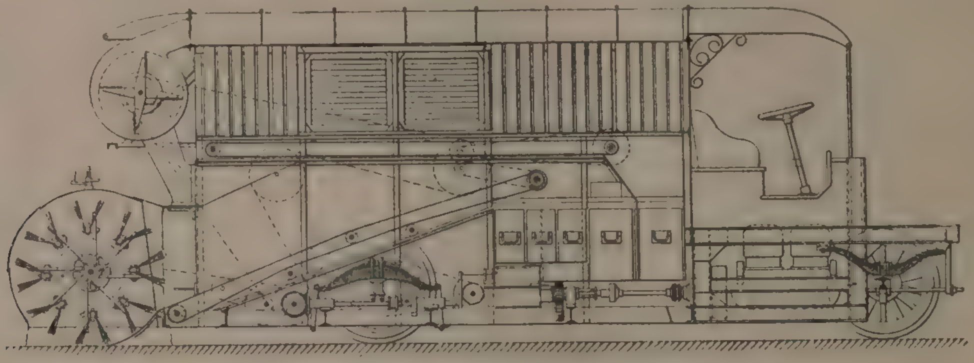
Most of these causes for slowing up the riveting gang boil down to the one fact that work is started before everything is ready. A job should never be started until you are dead sure that everything is ready to go through with it.

Vacuum Street Cleaning in Western Cities

After many years of experiment, street cleaning by vacuum apparatus seems to have become an established practice in some of the Western United States cities, according to Engineering News Record. At the Panama-Pacific Exposition the pavements were cleaned daily by one of the newest types of these vacuum cleaners, a combination of a sweeping and suction machine.

Rotary Broom Adjustable

It has a power-driven rotary broom 8 ft. 5 ins. wide by 3½ ft. in diameter, fully inclosed and so constructed that when it is worn it can be extended and readjusted to give a proper sweeping surface at all times. It can be used down to the stub. All heavy dirt and particles picked up are swept by this broom upon a conveyor and deposited in iron receptacles, which are easily removed from the machine. These receptacles hold about a barrel each.


Type of vacuum street cleaner used in western cities.

For taking up dust and light floating particles, there are two fans placed directly over the broom. This arrangement effects the separation in the machine of the heavy dirt and the light dust. The air and dust pass through a separator screen where the dust and fine particles settle on the lower platform, and a small conveyor running at about 30 ft. per minute carries this material into the front receptacle. The broom is driven by self-adjusting rope transmission as shown. The broom carriage is hinged to the back of the machine and rides on a pair of small wheels practically independent of the sweeper itself, thus permitting it to adjust itself to unevenness in the surface of the pavement.

The broom and fan drive is taken from the main shaft just in front of the transmission, and the clutch is so arranged that the machine can be driven and operated independently of the broom. The sweeper truck is built very low, and its wheels are fitted with solid rubber tires. The speed of operation naturally varies according to the amount of dirt to be removed, but in ordinary work it will maintain a speed of from 8 to 10 miles an hour with a sweeping capacity of 250,000 square yards in eight hours.

At the Exposition a Butler machine, traveling from 45 to 50 miles each night, kept the whole of the grounds clean, with the exception of the smaller courts, which were too narrow to permit its operation. The contract for cleaning the exposition grounds was taken at 40 cents per 1,000 square yards, and it is stated that a profit of about $15,000 was made in the ten months on one machine. The next lowest bid was 47 cents per 1,000 square yards. This very machine had previously been in operation in Oakland, and at the close of the exposition had run 27,000 miles and was still in good condition.

The accompanying data are from an official report on tests of a Butler street cleaner made by W. W. Thompson, assistant deputy superintendent of streets, Oakland, Cal.

Data on Performance of Machine

Resweeping Clay St. from south line of Third St. to the south line of Seventh St.

Length	1040.5 ft.
Width	52.6 ft.
Area	6,080 sq. yds.
Starting time	6.30 a.m.
Finishing time	6.58 a.m.
Dust	97 lb.; 1.89 cu. ft.
Street sweepings	112 lb.; 2.77 cu. ft.
Gutter sweepings	200 lb.; 5.45 cu. ft.

Resweeping 25th St. from east line of Grove St. to west line of Telegraph Ave.

Length	1,023 ft.
Width	31.9 ft.
Area	3,625 sq. yds.
Starting time	7.37 a.m.
Finishing time	7.44 a.m.
Dust	72 lb.; 1.44 sq. ft.
Street sweepings	24 lb.; 1 cu. ft.
Gutter sweepings	91 lb.; 3.67 cu. ft.

Resweeping Piedmont Ave. from east line of Broadway to north line of Echo Ave.

Length	4,357 ft.
Width	52 ft.
Area	25,173 sq. yds.
Dust	69 lb.; 1.44 sq. ft.
Street sweepings	383 lb.; 8.31 cu. ft
Gutter sweepings	335 lb.; 13.85 cu. ft.
Total clean-up of sweepings	1½ cu. yd.
Sweeping time	1 hr., 25 min.

In Los Angeles, Cal., a contract was awarded last fall to W. W. Baxter for street cleaning by vacuum

(Continued on page 528)

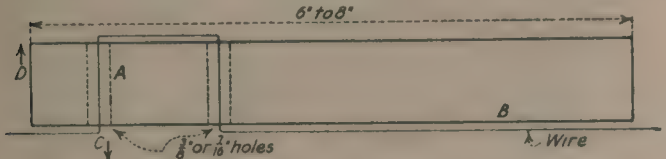
Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Compressed Air Fittings Prevented from Pulling Out by Simple Means

By H. B. McDermid

SOME time ago the writer was employed in repairing riveting machines and their appurtenances for a gang of riveters on tank work. All the rivets were driven cold, the men were all paid by the piece, and strike conditions prevailed. The wear and tear on equipment under these circumstances was very severe, but in no place was it more marked than in the way the fittings were constantly pulling out of the tail or buck hose. We are carrying 110 pounds of air pressure on the lines, and this, coupled with rough handling, would pull out fittings some days faster than a man could put them in. All sorts of patent clamps were tried, but none proved equal to this job.



Simple device fastens fittings on air hose to stay.

I was about to give up in disgust when one of the gang told me of a tool that solved the problem in the neatest way that I have ever seen during fifteen years of construction work.

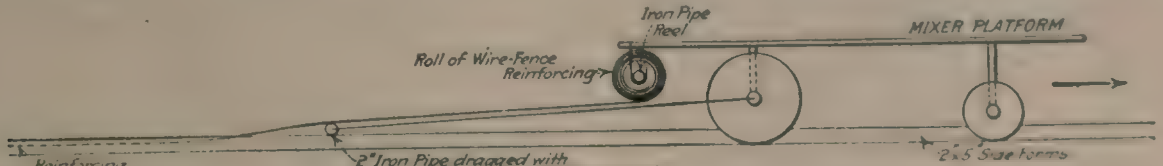
He took a hammer handle, sawed off a piece 6 to 8 inches long, then bored two ⅜ in. holes through it; the first ½ in. from the end of the handle, the other parallel and approximately 1 in. further up the handle, as shown in the sketch. He then laced a wire of about 16 gauge through the holes, as shown above. The wire was pulled through hole A until 4 or 5 in. protruded. It was then clamped in the vise along with the fitting, which had been previously forced into the hose, and the wire was then tightly wound over the hose, the tension being regulated by lightly holding the wire against the handle, with the hand at B. The hose may be at C, in which case the direction of rotation is as shown by the arrow; or at D, when the direction is opposite, as again shown by the arrow. Having the wire and hose clamped in the vise, my man commenced to wind the wire down the length of the fitting as tight and close as ever a wire was wound on a spool; then back with three or four turns to the starting point, and there the two ends were twisted together with pliers in the ordinary manner, and the job is done to stay. It is hard to believe what an enormous pull can be exerted on that wire. In fact, the novice at his first attempt will probably pull his wire in two several times before he gets the correct notion of the pull he is exerting. But in no case will the fitting ever again pull out. In hundreds of cases I have never known a blowout. Neither use, pressure, nor abuse has any effect on a joint well made in this manner—the hose always wears out first before the fitting gives trouble.

This work was all done on a ¾ in. and 1 in. hose, but there is no reason why it should not do for any size, or, in fact, in any place where it is desired to do a snug, tight job of winding wire. The convenience of the tool is further enhanced by the fact that it is cheap, can be made anywhere, any time, by anyone, and can always be depended on to do a tight, neat job.—Engineering and Contracting.

Mixer Stretches Reinforcing

THE scheme shown in the accompanying sketch, from Engineering News-Record, was used to eliminate considerable work formerly required for unrolling, raising, and stretching the wire fencing used in reinforcing some concrete roads across boggy ground in California.

The pavement on the stretches of road referred to is 16 ft. wide and 5 in. thick, and three widths of 60 in. wire fencing were used for reinforcing. The plan devised for handling it, which proved quite effective, was to run an iron pipe, to be used as a reel, through the centre of the three rolls of reinforcing and hang the pipe on hooks attached to the floor of the mixer. Another pipe was placed under the reinforcing and on top of the side forms of the pavement, keeping the reinforcing off the ground. This pipe was dragged behind the mixer by wires tied to the hubs of the rear wheels, and was adjusted so as to stay just ahead of the concrete spout. Thus as the mixer moved ahead the reinforcing was automatically unrolled, stretched, and held at a fixed distance off the ground by the pipe laid on the forms.


Iron Pipe Reel
MIXER PLATFORM
Roll of Wire-Fence Reinforcing
Reinforcing
2" Iron Pipe dragged with Wire attached to Hubs of Rear Wheels
2 x 5 Side Forms

Mixer unrolls, stretches and places road reinforcing mesh.

Hollow cylindrical reinforced concrete piles have been used at Liverpool. They are lighter and cheaper than solid piles, and, in the opinion of many, more effective.

New Canadian Plant for the Pittsburgh-DesMoines Steel Company

Canadian purchasers of steel products will be interested to learn that the Pittsburgh-Des Moines Steel Company, formerly known as the Des Moines Bridge & Iron Company, with works at Pittsburgh, Pa., and Des Moines, Iowa, has recently established a plant at Chatham, Ont. This Canadian branch of the company, known as the Canadian Des Moines Steel Company, Limited, has purchased the property of the Chatham Bridge Company, Limited, and has enlarged and completely equipped this plant to handle the manufacture of all standard types of steel structures, including mill buildings, office buildings, fire escapes and bridges. In addition to this they will also make a specialty here, as in the States, of the manufacture and erection of elevated steel tanks and other special structures, such as standpipes, storage tanks, smoke stacks, barges and coaling stations.

A municipal water tower of 200,000 gallons capacity.

The elevated steel tank manufactured by this company, for storage purposes, has found special favor in the fields of municipal, industrial and railway service. It provides a very satisfactory means of supplying water under pressure to a distributing system. It furnishes a reliable watertight structure of simple lines and pleasing appearance which fits in well with any surroundings. The storage capacity of tanks used in this connection may vary from a few thousand gallons for a private system up to a million gallons supplying a large municipality with water for domestic consumption and fire protection. It is considered that a storage of fifty gallons per capita is sufficient for domestic supply. This amount may be doubled if the supply in addition is to be used for industrial service and fire protection. The tower may be of any height to provide the necessary pressure. The cut shown illustrates a municipal water tower of 200,000 gallons capacity. At latitudes where severe weather is experienced, these tanks are fitted with special heating arrangements.

This company has also built a number of wireless towers with heights from 100 to 600 feet.

In future all sales in the Canadian territory will be handled from Chatham, and all steel for delivery in Canada will be fabricated at this point.

Vacuum Street Cleaning

(Continued from page 526)

cleaners known as the Baxter machines. This contract was for three years at the rate of 10½ cents per 1,000 square yards. This type of machine, it is estimated, will clean 220,000 square yards of pavement in eight hours. It has no rotary broom.

Another type of vacuum cleaner, which it is claimed has been used with success at Sandusky, Ohio, and other places, is the design of Bernard Kern and is known as the "Waycleanse suction street cleaner." This machine has a detachable three-wheel van, or portable bin, for collecting and transporting the dust and sweepings.

The Far West cities where vacuum street cleaners seem to have met with the most success are in relatively arid sections. In these cities ordinary street refuse is speedily reduced to dust, and the damp, slimy conditions met with in Eastern cities, or in the coast cities of the Northwest, are seldom encountered.

Steel Company's Representative

W. A. Maclennan, B. C. representative of the Steel Company of Canada, with head office at Hamilton, Ont., has removed his headquarters from the Old Safe Block, corner Hastings and Seymour Streets, Vancouver, to more modern and commodious offices in the Credit Foncier Building, opposite the Vancouver Club, Hastings Street West.

New Books

Paving Economy—Road and Street—by Charles A. Mullen, director of paving department, Milton-Hersey Company. Published by the Industrial and Educational Press, Montreal; 98 pages; 5½ x 8½ inches; paper binding; price, $1. This treatise is directed particularly to city officials, road superintendents, publicly interested citizens, and others who may find themselves in need of a working knowledge of road and street pavement values. No attempt is made to consider the contracting side of road work, discussion centering mainly on the financial and economical aspects that should be viewed by civic officials who want to get the most value from the public's point of view. The various types of paving surface are compared as to the special features in the wearing surface that are most desirable from the physical point of view and as to the main points that enter into their financial economy, with the object of seeking a pavement that gives the best value for the money, all things considered.

How to Build Up Furnace Efficiency—by Jos. W. Hays, combustion engineer, Chicago. Published by the author; 154 pages, illustrated; 5 x 7 inches; paper binding; price, $1. In this, the tenth edition of a popular treatise on combustion, the purpose is to show why, how, and where fuel is wasted in the boiler-room, and to indicate what proceedings to take to effect a reduction in the coal bills. The distinctive feature of this book is the popular narrative style of writing adopted by the author to discuss a subject usually considered abstract. By making a liberal use of anecdotes for purposes of illustration and dwelling on the humorous phases of boiler-room practice, he stimulates an interest that is sustained to the end. Very little is said in the book relating to the theory of combustion. The sole aim is to discuss its practical aspects in such a way as to satisfy those managers, superintendents, engineers, and firemen of the power plant that want results first and are content to let theory rest until results are accomplished. The question of building up boiler-room efficiency is discussed under five heads: Why your fuel is wasted; how your fuel is wasted; how to spot your fuel wastes; how to stop your fuel wastes; how to keep the wastes stopped. Charts, diagrams, and illustrations of apparatus are used to make clear some of the things difficult to explain in the text and to show the proper appliances for prosecuting combustion studies. An appendix applies to the use of oil, gas, wood refuse, and other fuels.

Trade Publications

The Portland Cement Association has issued a pamphlet entitled "Concrete Tile and Land Drainage," outlining what land drainage will accomplish and the value of the concrete type of tile for this work. Book will be supplied free on request.

Modern Methods of Brick Pavement Construction, published by the Dunn Wire-Cut Lug Brick Company, describing and illustrating the manufacture of wire-cut lug bricks and their application in pavement construction.

Mainly Constructional

East and West—From Coast to Coast

Beattie Brothers have awarded the contract for steel sash on their new factory at London to the A. B. Ormsby Company.

During the month of May, 19 building permits were issued in Galt, Ont., valued at $24,820. The total for the first five months of the year is $57,000.

During the first five months of this year permits have been issued in Welland, Ont., to a total value of $133,145, as compared with $99,196 in the corresponding period in 1916.

The total value of the building permits isued in the city of St. John, N.B., during the first five months of the year amounts to $404,400, as compared with $245,700 for the same period last year.

During the first five months of the year there were 670 building permits issued in the city of Montreal, valued at $2,108,914, as against 743 permits during the corresponding period in 1916, at a value of $1,686,294.

The A. B. Ormsby Company has been awarded the steel sash contract for Luney Brothers' building, Victoria, B.C.; also the skylight contract on the new power station at Duncan and Nelson Streets, for the Toronto Hydro.

A surplus lot of 22,440 feet of iron pipe of various sizes, accumulated by the engineering department of the city of Vancouver during the boom days, is to be disposed of to the city of Trail, West Kootenay, for waterworks purposes.

An old fish plant at Pacofi, Queen Charlotte Islands, has been turned into a factory for the treatment of kelp. All of the numerous by-products of the seaweed will be extracted. A smaller plant is located at Sidney, Vancouver Island.

The Dominion Shale Brick and Sewer Pipe Company, Ltd., operating a big plant near Nanaimo, recently made an assignment for the benefit of creditors. The trouble was brought about by the severe depression in the building trade since the outbreak of the war.

Work has been carried out by the C.P.R. on extensive freight sheds at Lambton, Ont., on the site formerly occupied by their station. The latter building was transported a mile further west. On either side of the 800 foot sheds the company is laying down three extra tracks.

City Engineer Rust, Victoria, delivered an illustrated lecture on May 16 before the local branch of the Canadian Society of Civil Engineers, his subject being the Sooke Lake waterworks system. In addition to a large gathering of members, many citizens were present.

The tender of the John ver Mehr Engineering Company, Ltd., of Toronto, for the installation of a new filtration plant at Oshawa has been accepted by the local board of water commissioners, subject to the approval of the Provincial Board of Health. The plant will be of the Ransome drifting sand type.

Permits isued in the city of Vancouver for the month of May, 1917, number 54, ,and are valued at $47,975. This compares with 58 permits, valued at $72,980 in the same month last year. The total for the first five months of the year is 222 permits, at $281,339, as against 170, at $291,330, during the corresponding period in 1916.

Building activity in Windsor, Ont., continues very strong. During May, 74 permits were issued, at a value of $116,955, as against 52 permits valued at $88,705 in the same month last year. The total of the permits for the first five months of the year is 255, at a value of $469,860, compared with 187 during the corresponding period in 1916, valued at $388,860.

Civic representatives of Sarnia, Ont., have been visiting several cities in Western Ontario for the purpose of inspecting their incinerator plants and gathering data regarding the cost of installation and maintenance. It is stated that the Sarnia City Council is in favor of having an incinerator installed, as the only satisfactory way of disposing of their garbage.

Marsh, Hutton, Powers Company, Ltd., New Westminster, have about completed work on the jetty on the South Arm of the Fraser River below Steveston, the last unit now being installed. A similar work will shortly be undertaken on the opposite bank of the river, the idea being to confine the water to its channel and keep it from flooding the flat lands. The scheme was evolved by LeBaron, a French engineer, consulted by the Department of Public Works, Ottawa, some years ago.

An announcement has recently been made by Mr. W. A. McLean, Deputy Minister of Highways for Ontario, that this province is to employ at least 6,000 men in building good roads after the war. Mr. McLean says: "Our department is seeking to interest the public in good roads with a view to greatly extending the work after the war, and the employment of 6,000 men, or the equivalent of six battalions, will be a considerable step towards equalizing the difficult situation which will certainly be with us after the war."

The Brick, Terra Cotta and Tile Company, of Corning, N.Y., Mr. M. E. Gregory, proprietor, has become a licensee of the Dunn Wire-Cut Lug Brick Company, of Conneaut, Ohio, and will engage in the manufacture of wire-cut lug paving brick. This company is one of the most important paving brick concerns in that section of the country, and is widely known for the quality of its product and the reliability of its business methods. Mr. Gregory, the proprietor, is one of the leading business men of that section.

Messrs. Yarrows, Limited, who have a large shipbuilding and repair plant at Esquimalt Harbor, near Victoria, have accepted a contract to construct another steel stern-wheel vessel of light draught, similar in design to several turned out during the past twelve months, for use on inland water in India. The boats are [illegible] feet in length, with a beam of [illegible] feet and draught of 3 feet. Like the others, the third craft will be shipped in knock-down form on a Blue Funnel liner, the boilers and machinery going direct from Glasgow to the point of destination.

The Halifax Housing Company, Ltd., of Halifax, N.S., has been established to erect a number of modern, sanitary, four-roomed cottages, at a minimum rental, on the north slope of Fort Needham, where there is space for about fifty double tenements. It has been decided to erect the first group, at least, of wood, though the original intention was to erect all of fireproof materials. The change is made necessary because of the high cost of materials. The capital of the company is to be $50,000, in 1,000 shares, while it is proposed to raise as required an additional $90,000 on mortgage, making a total fund available of $140,000.

The Foundation Company of British Columbia, Ltd., a subsidiary of the Foundation Company, Ltd., Montreal, has just been formed for the purpose of building ships. An order has been obtained, through the Imperial Munitions Board, for ten wooden vessels of 3,500 tons each, and a shipyard will be constructed at Victoria for this purpose. Mr. R. L. Dalton, of the Montreal office, is the treasurer of the new company, while Mr. W. I. Bishop, of Montreal, will be the superintendent of construction. Mr. Dalton has left for the coast. The Foundation Company in the States has an order for a number of wooden vessels.

The ratepayers of Port Coquitlam are considering a proposition to bonus an electrical steel-making plant which is being promoted by A. F. Bernstein, of Vancouver. If the proposition goes through, the plant will have four 4,000 kw. furnaces, capable of producing 30 tons of iron each per diem. These will be continuous furnaces—as the ore is reduced it will be run into a crucible, where it will be refined by the addition of fluxes and the impurities slagged off. With the addition of certain alloys any desired grade of steel may be produced. A rolling mill capable of turning out 100 tons of steel per day is part of the scheme, which is to be voted upon by the property owners.

The judges in the annual split-log drag contest of the Manitoba Good Roads Association have carried out their first inspection of the stretches entered in the competition. The competitors include the Municipalities of Macdonald, Charleswood, Rockwood, Rosser, St. Vital, Ritchot, and Springfield. Each stretch must be inspected three times, at intervals, during the season. The judges will have to travel nearly 1,000 miles in order to complete their duties. Keen interest is being shown in the competition, and the roads, as a whole, are said to be better this year than ever before. The judges are Messrs. A. McGillivray, highway commissioner for the province; S. A. Henderson, president Manitoba Good Roads Association; and A. C. Emmett, secretary Manitoba Motor League.

The semi-annual report of Road Superintendent J. M. Young of Wellington County, Ontario, was recently presented to the County Council. The report stated that the county roads were, with a few exceptions, in a fair state of repair, and if road drags or graders could be operated on them to fill in the ruts they would be in good condition for the remainder of the season. The purchase of several good road drags was recommended. The road machinery had not commenced work, as the season was not favorable, and labor scarcity was a serious problem. The work laid out for construction with the road machinery included county road No. 8, Maryborough; 29 and 31, West Garafraxa; Mill and Main Streets, in Palmerston; 2 and 11, Puslinch; 20, Guelph Township; 4, Eramosa; street to station, Fergus. The report mentioned a number of bridges which were in an unsafe condition and would require new structures, including Brown's, Arthur Township; Mitchell's, Arthur Township; Belwood, West Garafraxa; Goldstone, No. 32, Peel; Bye's, No. 5, Pilkington; Hillsburg, No. 24, Erin Township; O'Donnell's, No. 17, Luther and Arthur Townships. A number of bridges were also reported to be in need of repair. It was further stated that a great many new culverts would be required on the several county roads, and that a large amount of draining would be done in order to benefit the roads in many municipalities.

Personals

Lieut.-Col. C. H. Mitchell, M.Can.Soc.C.E., D.S.O., C.M.G., of the firm of C. H. & P. H. Mitchell, consulting engineers, Toronto, was among those upon whom honors were conferred on the occasion of the King's birthday.

Lieut. J. A. Gordon White, formerly with the Mond Nickel Company, Victoria Mines, and later in the hydraulic department of the Hydro-Electric Power Commission of Ontario, has been awarded the Military Cross. He is a graduate of McGill, 1911, applied science.

Mr. R. T. Bell, formerly with the National Transcontinental Railway as division engineer, and latterly with the Toronto-Hamilton Highway Commission as construction superintendent and at Camp Borden in a similar position under Col. Low, has been granted a commission as captain of the 23rd Draft Reinforcements for Canadian railroad troops.

Brigadier-General F. O. W. Loomis, of D. G. Loomis & Sons, contractors, Montreal, and Major E. G. M. Cape, president of E. G. M. Cape, Ltd., Montreal, contractors, are among the Canadian officers' names submitted by Sir Douglas Haig as deserving of special mention. Both officers are also included in the King's birthday honors; Brigadier-General Loomis has been made a C.M.G. and Major Cape has been awarded a D.S.O.

Messrs. Ernest A. Cleveland, M.Can.Soc.C.E.; Donald Cameron, M.Can.Soc.C.E., and Stuart S. McDiarmid, B.Sc., who have conducted a consulting engineering business at Vancouver for several years, under the firm name of Cleveland & Cameron, have dissolved partnership. Mr. McDiarmid has received a commission in an overseas draft of the forestry battalion, while the other two partners will each continue business on his own account.

Obituary

George Alexander Stewart, C.E., who died on May 13, at his home in Victoria, at the advanced age of 87 years, was at one time well known in Eastern Canada, and in various ways was prominent in the early days of the Dominion. He spent his boyhood on the site of the present city of Peterboro (named by his mother at the request of Sir Peregrine Maitland, then Governor-General of Canada), and later took up civil engineering under Sir Sandford Fleming. After passing his examinations he assisted in the construction of the first railway built in Canada; was assistant engineer of the Northern Railway from 1852 to 1854; practised his profession at Port Hope from then until 1865, and was chief engineer of the Midland Railway from 1868 to 1877. A long wooden pontoon bridge built by Mr. Stewart in 1866 across an arm of the Bay of Quinte—the first bridge of its kind erected in Canada—still continues to give good service. Later in the same year he was commissioned to make topographical surveys of the Rocky Mountain National Park, Banff, Alta., and was in charge there for eleven years, following which he returned and removed to Victoria. He was a member of the Royal Society of Civil Engineers, and at the time of the "Trent" affair he recruited and commanded a company of engineers at Port Hope.

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Principal Contents

Page

Editorial 531
Engineers in Canada Organized for War 533
Present Estimating System has Drawbacks 535
Sewage Disposal for Isolated Houses 536
Physical Properties of Pavement Surfaces 538
Accidents on Construction Work 541
Water Tanks for Winter Use 542
Steam Power Plant of Granby Consolidated Mining, Smelting & Power Co., Ltd. 544
Refuse Destructor Clinker Successfully Utilized for Road-making 545
Co-operation of Engineers for Recognition 546
Practical Hints for the Contractor 548
Mainly Constructional 549

The Need of Industrial Bureaus

THE annual convention of the Canadian Manufacturers' Association was held in Winnipeg during the week beginning June 11. Mr. S. R. Parsons, of the British American Oil Company, Toronto, was unanimously chosen to succeed Colonel Thomas Cantley as president of the association for the coming year. Other officers are: Vice-president, W. J. Bulman, Winnipeg; second vice-president, T. P. Howard, Montreal; treasurer, J. F. Ellis, Toronto (succeeding George Booth, of Ottawa, who has held the position for thirty years and has now resigned).

A number of important resolutions were passed by the manufacturers, including one dealing with the recent report of the Drayton commission on railway nationalization, and suggesting to the government that immediate steps be taken to assist in overcoming the desperate need of equipment by providing cars and locomotives. Other resolutions favored: (a) A scientific survey on the part of the C.M.A. as an aid in shaping taxation policies; (b) some action by the provincial governments to prevent the present huge annual fire waste; (c) the elimination of all government patronage in the granting of contracts and the introduction of full and free competition; (d) the establishment of libraries and laboratories for the furtherance of industrial research.

* * *

In connection with the latter resolution, namely, the establishment of industrial research bureaus, it may be pointed out that this matter has been discussed by the recently-appointed Advisory Council, and a recommendation has been made to the government by that Council. It is difficult to understand how public money could be more wisely spent at the present moment to assist commercial development than in the establishment of research libraries and laboratories, which would make possible the solution of many problems that, at the present moment, retard our industrial progress and prevent Canada from taking as prominent a place in the commercial world as her natural resources amply justify. Up to the present time Canadian manufacturers have sought government protection against the inroads of competitors largely on the argument that they were unable to compete with the older established and larger organizations of foreign countries. This has resulted in a certain industrial development for which the consumer paid but from which the manufacturer has reaped no special benefit. It would not appear, therefore, that this was the best form of assistance the government could have given to our young industries. Tremendous developments have taken place during the last few years as regards industrial procedure, these being largely the result of investigation and research. It might thus have been much better if the Canadian Government, years ago, instead of protecting and fostering inefficiency in the form of out-of-date processes, had placed at the disposal of our young industries the means of themselves improving their methods of manufacture and general operation, so as to be in a position to meet world competition—the underlying idea in the present suggestion for the establishment of industrial bureaus.

* * *

Many of the problems met with daily in our Canadian industries have already been solved in other countries and the solutions published either in magazine, pamphlet, or book form. For this reason the establishment of good industrial libraries in certain centres would seem to be the first step towards a greater commercial development. For the problems which are yet unsolved we have either the alternative of tackling them ourselves in our own laboratories or sitting tight while other countries solve them and reap the benefits. This would mean that Canada continues to lag along behind her neighbors industrially, which means, again, that the past and present system of coddling will have to be continued indefinitely. Plainly, the proper course is to supply our industries with the means of developing their own strength and growth so that they may be self-supporting. Industrial libraries and industrial research laboratories are, as shown by the history of our foreign industrial competitors, undoubtedly one of the best means of fostering industries. Let us have them immediately, then, that Canadian industries may stand on an equal footing with those of foreign countries.

The Cheaper Types of Road

THE greatest part of current road-making literature deals with roads of the so-called permanent type. Attention is being further concentrated on this type of road or pavement by extensive advertising and publicity propaganda. To such an extent is this true that there is a tendency to forget that other varieties exist. Concrete, asphalt, brick, granite block, various proprietary surfaces, and many other hard-surfaced roads are being so largely advocated that the cheaper surfaces are in danger of being considered non-extant. We cannot overestimate, of course, the importance of these more or less permanent road surfaces, but it must be remembered that for every mile of such roads there are tens of miles of a less lasting variety. The majority of roads in our rural districts to-day are earth or clay and gravel. Where any attempts are made to secure a more durable and lasting surface these are rarely carried beyond a process of macadamizing, and in most cases the simple water-bound macadam is considered sufficient.

The bituminous, concrete, or block types of road, alone and in various combinations, are quite as effective as anything known for the carrying of heavy and diversified traffic. They are expensive, however—so much so that their use is justifiable only where the return incident upon their incorporation in a road is comparable with the cost. This condition will apply only to main or trunk roads where the traffic is sufficiently dense to warrant a condition of practical permanence and require a road of suitable width and location to carry such traffic. The vast majority of our roads, however, must still be secondary. They carry a traffic insufficient to justify large expenditures, and, for this reason, lower grade and cheaper materials must be looked upon to fulfill the requirements. This fact must not be lost sight of, although the tendency of current literature is to discredit the cheaper roads and thereby exert a certain influence upon road-building municipalities to lay more expensive roads to their own financial loss and the detriment of the whole road-building industry.

Of course, improvement to the cheaper roads must be looked upon as a necessity in time. This improvement may be but a surfacing of gravel to an existing clay road, and in many instances such a procedure will be all that is justifiable and indeed necessary. If gravel is located sufficiently near the road site, this form of improvement is to be generally commended where traffic does not warrant a permanent surface. For hundreds of miles of our roads, however, earth and clay are all that will, for many years, be used. The earth road is admirable where traffic is of local importance, provided it is well drained and carefully and systematically maintained. It must be remembered, too, that a good earth road will make an excellent foundation for more lasting surfaces, and that, therefore, until such improvements are rendered necessary by the exigencies of traffic, the earth road should be kept in the most efficient state of repair.

If materials are sufficiently available, the gravel or water-bound macadam makes a cheap road surface of great usefulness and effectiveness. The latter, while formerly the standard of high-class construction, is now classed among the more mediocre surfaces. The day of its usefulness has not passed, however, and there are still openings for its employment where economic considerations render it desirable.

The fact that needs to be impressed is that, while bitumen or concrete, or a number of other materials, may approach the long-sought perfect road surface, it is a matter of dollars and cents that counts in the end. We cannot have ideal pavements on all of our roads. Then let us have them by all means where they will prove their greatest usefulness. On the greater number of our rural highways, however, the cheap roads are all that are defensible, and, in fact, all that are desirable. In view of this, study must not be wholly concentrated on the high-grade roads to the detriment of those less expensive but just as useful types.

Vancouver Officials Get Salary Boost

ONE of the convincing proofs of the rapid recovery of Vancouver from the depression which set in coincident with the declaration of war is afforded in the readjustment of civic salaries to the figures which prevailed during the good times preceding the slump. The wages of the police, firemen and city workmen were advanced in the beginning of the year, and at a meeting held late in May the city council agreed the time had arrived when the salaries of corporation officials should be restored to the former figures, as follows:

	1916	1917
City solicitor	$3,000.00	$3,300.00
Special counsel retainer	2,400.00	3,000.00
City comptroller	3,274.40	3,300.00
City Engineer	3,300.00	3,300.00
City medical health officer	3,272.40	3,300.00
City treasurer	2,475.00	2,500.00
City clerk	2,475.00	2,500.00
City accountant	2,680.80	3,000.00
City assessment commissioner	2,475.00	2,500.00
City auditor	1,754.40	2,000.00
Works secretary	1,760.40	1,800.00
Purchasing agent	2,227.00	2,225.00
Paymaster	1,584.00	1,620.00
License inspector	1,584.00	1,620.00
Assistant Trades License inspectors	1,161.60	1,200.00
City clerk's first assistant	1,452.00	1,500.00
City janitors—		
First	987.60	960.00
Second	831.60	900.00
Third	772.20	840.00
Waterworks foreman	1,760.40	1,800.00
Chief meter clerk	1,320.00	1,380.00
Bookkeeper (water)	1,200.00	1,320.00
Relief officer	1,800.00	2,100.00
Plumbing inspector	1,418.00	1,560.00
Assistant	1,012.00	1,260.00
All chief clerks	1,320.00	1,500.00
Mayor's secretary	1,320.00	1,500.00
Building inspector	1,650.00	1,680.00
City electrician	2,227.50	2,400.00
Assistant electrician	1,539.00	1,560.00
Superintendent fire alarm and police patrol systems	1,710.00	1,740.00
Fire department electrician	1,200.00	1,260.00
City industrial commissioner	1,500.00	2,100.00

If every shipper whose commodities have to make a rail trip before reaching the consumer were to load cars to maximum, or the 10 per cent. excess authorized, there would be little or no car shortage. For example, one of the large cement manufacturers has recently made good in this respect by loading all of its shipments to 108 per cent. of the marked capacity of cars.

The Portland Cement Association is now printing the second large edition of its cement stave silo booklet, which was issued only three weeks ago. Manufacturers of silo staves, and cement stave silo builders say that the prospect for a good silo building year is far beyond normal.

Engineers in Canada Organize for War

Canada's Participation in the War Has Introduced Problems Which Require Engineering Solutions—Industrial Development Must Expand After the War

IN Chicago recently an engineering conference of delegates representing 50,000 engineers was held, with a view to urging co-operation of the engineering bodies of the United States. At the conference it was determined that no new society was needed, but that by organizing all of the existing bodies it would be possible to attain the desirable co-operation. What was regarded as the most prominent single feature of the meeting was a presentation of how the Canadian societies met the war crisis, by J. S. Dennis, president of the Canadian Society of Civil Engineers. This address, delivered on the verge of the United States' entry into the war, was full of ideas that would prove invaluable in time of crisis. In urging a democratic federation of all societies, Mr. Dennis pledged the support of Canadians. Extracts from the address follow:

We in Canada also have the problem of the federation of engineering societies confronting us. We have all the branches of the engineering profession represented in different societies or clubs, and our desire is to try and federate and consolidate them into one central organization, at least in so far as a central board is concerned.

Our main object in the Canadian Society of Civil Engineers is to encourage, as far as Canada is concerned, exactly what I understand you are aiming at—that is, a federation of all of the engineering societies in Canada—and we have under consideration the change of our name so as to extend an invitation for all to come in and create a big federal organization. My particular object this year as president of the Canadian Society of Civil Engineers is to endeavor to get the society to go outside of the ordinary routine of strictly professional or technical subjects and take part in the bigger and broader problems that are confronting us in Canada as a result of the war, and in this, I may say, we have accomplished something.

War Has Introduced Problems

We have in Canada certain problems which have come to us as a result of our participation in the war. Probably among the most important of these is the question of how we can increase the production of our country by the development of our natural resources. We think Canada has been blessed by nature with almost inexhaustible resources of water-power, timber, minerals, agricultural lands, and so on, and therefore, as a society, we are urging that special study be given to the question of how Canada's natural resources can best be developed. Our Dominion authorities have created a commission to study this problem, and the chairman of one of their important sub-committees is the chairman of our finance committee.

We have in Canada another big problem connected with our transportation systems. Canada to-day has a greater mileage of railway in operation per capita than any other country on the face of the globe—some 35,000 miles of railway for a population of about eight million people. While the company I have been connected with for a good many years is "strong," some of the other companies are not in the same position, and we are, therefore, faced with the question of solving these transportation problems. A committee was appointed last year to consider the transportation situation and to submit a solution for consideration when parliament reassembles. A most interesting and valuable report on this problem was prepared by Mr. W. F. Tye, one of our members, also a member of the American Society of Civil Engineers. He presented his report as a paper read before one of the weekly meetings of the Canadian society at Montreal. We did with it as we do with all of our weekly papers—printed and distributed three or four thousand copies to our members, in addition to which Mr. Tye himself had printed and distributed about three thousand copies. As a result, before this debate comes off in parliament the people, as a whole, will have been well informed as to the existing conditions in regard to our railways and as to the possible methods of solution suggested through this paper.

Engineers Solve War Problems

In addition, engineers in Canada have been called upon to advise and take a certain part in the solution of many of the great war problems that we are now facing. War to-day is a matter of science. Immense changes have taken place in the conduct of war in the last few years. The last war that Great Britain was concerned in was that of South Africa. The war of to-day is an entirely different proposition. The experience of the British army in the South African War has been the foundation of many of the methods used in this war—that is, the system of warfare introduced by the Boers in South Africa of fighting in trenches, protected by barbed wire, was the basis of the trench system of the present war. The present system of trenches, protected by wire entanglements, was adopted by practically all of the warring nations as a result of that experience, and to-day on all the fronts in this war the great demand has been for barbed wire—in fact, one of the greatest difficulties has been to get a sufficient amount of barbed wire to go around.

The appliances used in connection with war nowadays are wholly a matter of engineering science. Whether it is a question of aircraft, submarines, high explosives, guns, projectiles, rifles, tanks, or motor power, or some particular kind of trench and protective work. Through the whole list you will notice that the engineering profession, in some branch, comes into play. Beginning with high explosives, you know the change which has taken place through the investigations of chemical engineers, until to-day the explosives used in warfare differ entirely from those used fifty years ago.

Engineering Science Universally Involved

In the matter of guns: To-day the methods used in manufacturing guns (I mean when I speak of "guns," of course, artillery) is based upon different methods, and their use is entirely different from that formerly used. Our modern rifles are entirely different, and hundreds of new mechanical appliances are being used, so that it may be claimed that war to-day brings into play a greater number of engineering activities than was ever dreamed of in past wars. As a consequence, throughout all the armies of all the warring nations the engineer is playing a very prominent part.

In Canada the war has affected us very materially. We are but a small population, occupying a large part of this North American continent. When the war broke out there was not an obligation upon a single man in the Dominion of Canada to take up arms; no law to force him to take up arms; no condition existing upon which he could be called upon to go and take part in this war. Action by the people of Canada in getting into this war was of their own free will, and there is no existing law by which the British Government could call upon a single man. The movement was voluntary, and up to date we have provided something like four hundred thousand men. We hope to provide five hundred thousand men. Five hundred thousand men of a fighting age, out of a population of eight millions, is a large percentage. This is a young man's war; men of old age have no business in the war at all.

We pay our soldiers a higher rate than has been paid any soldiers in previous wars. We pay them $1.10 a day, and we also provide the family of each soldier a separate allowance of $20 per month. In addition, the people of Canada, feeling that the wives and dependents of the men at the front should not suffer, have up to date voluntarily subscribed about sixteen million dollars, all of which is going to the dependents of our soldiers at the front, making a general allowance to a military man's family of $60 per month.

The Scientific Side Has Imposed Difficulties

One of the difficulties we have in Canada in connection with our participation in the war has been the scientific side. We were not a warlike people in Canada. When war broke out we had to try and get the largest number of men possible in the shortest possible time and equip them. I would like to point out to you, in addition to moving and paying for a Canadian army, we are equipping them—that is, the four hundred thousand we have provided, and the five hundred thousand we hope to provide, have been entirely equipped in Canada. We provide everything—pay, maintain the men, their dependents, and provide pensions for them after the war is over.

Our great problem, as I have said, was the scientific side of it. We had very few men in Canada who knew anything about modern warfare. There are few engineers in Canada who know anything about modern military engineering, and one of our great needs in the earlier stages of the war was for an engineers' corps. We had only a small permanent military engineering corps, and one of the first things done by the engineers generally was to put themselves on record that they stood ready, subject to the call of the country. A great many of the older men knew that they could not go to the front, but might be of use at home.

The Canadian Society's Honor Roll

As president of the Canadian Society of Civil Engineers I am proud of the fact that we are putting up in our home building a roll of honor of the men in the engineering society in Canada who have gone to the front. That roll will comprise over 700 names. We are putting it up in the main hall of our building, with a proper inscription, containing the name and rank of every man who responded to the call. Unfortunately, already we are having to signify many of the names on that roll with a golden star, showing that these men have made the supreme sacrifice for the good of the country and their profession.

When we came to the great demand for guns and munitions resulting from the changed method of warfare very few people knew anything about it outside of Germany or France. Great Britain knew little about it, and on this continent we knew nothing about it. You have in the United States government arsenals that make munitions for your own guns, but they were not of the character of munitions used in Europe. They would have been useless in the character of campaigns carried on there now, and, therefore, both in the United States and Canada in the effort to meet the demand it was necessary to originate entirely new methods, and the success met with is largely due to the way in which the mechanical engineers responded to the call and took charge very largely of the installations in the munition plants which sprang up almost over night. As a result, in Canada to-day we have some four hundred thousand people engaged in the manufacture of munitions, largely of explosive munitions. We have had to create an entirely new equipment, but we have been able to get to the stage that, with the marvellous expansion in Great Britain in the same lines, it looks as if in the near future we will be able to manufacture most of our own munitions.

Chemical Engineering Has Made Greatest Advance

In addition to what I have said, there has been a marvellous work done by the chemical engineers. Chemical science in connection with the present war has probably made more rapid strides than any of the other branches of the profession. In the manufacture of explosives, in the manufacture of a thousand and one things used in this war, the chemical engineer has solved a great many problems. I am glad of having the opportunity of saying to you that some of the most serious problems connected with this phase of warfare have been solved in the United States. They were solved in a very remarkable way, and where time was an absolute essential. I have in mind one case that I have heard of, where it was absolutely necessary for the allied governments to be able to feel they were going to be able to get a certain product by a certain date. It was not thought possible. Two members of the chemical engineers of the United States stayed with that job, as we say in the West, for forty or fifty hours, without taking their clothes off, and it was solved twenty-four hours before it was thought possible.

After the War

There is no doubt but that, following the war, there is going to be a great demand for engineering experience the world over. Great Britain has suffered an immense loss in men, ships, material, and wealth, but her shores have not been invaded nor are they likely to be. On the continent of Europe the destruction is beyond human comprehension, and in connection with rehabilitation of these countries engineers will be greatly in demand. In Russia the opportunities after the war are going to be very marked. Russia is a marvellous country. The new government will probably follow a much more progressive policy and do much to extend the development of that country. There are Russian commissions now looking after industrial construction, dock installation, elevator construction, along the most detailed lines of costs and supplies of materials, which, if carried out, will involve an expenditure of many million dollars. Then in France and

Belgium there will be great openings for engineers, and it is reasonable to suppose that the engineering professions of the country who take part in the war will have the first call. We think that the men of the engineering profession in Canada who responded to the call of duty are going to have the first call in a professional way in the rehabilitation of these countries.

Must Expand Industrial Development

You will find in history that there has been a great influx of people to this continent following all European wars. After the South African War, when Great Britain had only 300,000 men engaged, statistics show that 120,000 of them came to the United States and Canada within one year of the close of the war. In the last Balkan war the statistics show that while the total immigration from the countries engaged was less than 14,000 the year before the war, within thirteen months after the close it had increased to over 47,000. In connection with the solution of this problem, we must both expand our industrial development and all the activities which require labor if we are going to take care of these people. We in Canada are facing this problem very seriously. We have the resources to develop, but we haven't much money. We hope that, following the war, we can interest you people living south of the imaginary boundary line, whom we look upon as our good neighbors, and whom possibly in the near future we may be able to welcome as our allies, to interest yourselves in Canada. You have the money, we have the opportunity; and we want to link up the opportunity with the money, so as to create in the northern part of this continent a civilization and a democracy which will absolutely prevent a recurrence of what is happening now. We hope to solve these problems along those lines, and, in doing so, no body of men in America can be of greater service than those men of the engineering profession who naturally have to face problems in a manner that the ordinary man does not meet.

Present Estimating System Has Drawbacks

Current Bidding Practice is Just a Gamble—Favors Those Who Make Biggest Mistakes—Quantity Surveying is the Business-Like Method

METHODS of bidding that are followed in building work in this country are considered by many as obsolete. The system of quantity surveying, already widely accepted in the Old Country, but little employed here, is regarded as possessing a multitude of advantages, besides being admirably adapted to the conditions of building work current here. The evils of the competitive bidding method are for the most part eliminated. Some of the drawbacks were set forth by Mr. G. Alexander Wright, one of the pioneers in the introduction of the quantity system, and an active worker in this movement, in a paper before the annual convention of the Society of Construction of Federal Buildings at Washington. Mr. Wright, in part, says:—

First, there is the enormous waste of time and money, by bidders all going over the plans and specifications, all doing the same thing, all covering the same ground, without arriving at the same result, in fact competing with each other as to how much material a building will take, each one apparently trying to see how little he can take off; anything, so long as he can beat the other fellow. This is gambling, not competition, nor legitimate estimating, consequently when it comes to pricing the items it is obvious that the bidders are more or less handicapped; no two bidders start on the same basis. No two bid on the same quantity of materials or labor. Some may be about right, others have too much, others too little. These latter are the men who, through their mistakes in taking "short" quantities as it is termed, so often land a job and beat the more competent bidder, who by being extra careful and accurate, does succeed in getting his quantities off more correctly, but if the truth must be told, the more careful and accurate a bidder is, the less chance he has of getting a job. Is any system which favors those who make the biggest mistake commercially sound? Is it business? Is it worthy, let me ask of a government department? Does this loose method pay those who put up buildings in the long run? Is it the best we can do?

Just a Gamble

The trouble which superintendents and architects have with a certain class of contractors in carrying on work, does not arise so much from the contractor's desire to make an unfair profit, as it does from his efforts to keep his losses down as much as possible, or at least to "break even," as we say. What would any man do under similar conditions? It is our wretched system, not the bidder, which is at fault. The lowest bid, which is the one most generally accepted, is usually anything but the most accurate (except from the owner's viewpoint) and correspondingly, the bidder is, under the present methods, not always able to give the best service for that reason. So true is this in private work, let on the so-called competitive system, that the average building contract, from start to finish, has degenerated into a game of chance, a gamble, an unhealthy contest. Such uncertainty is in itself a disturbing element. Why should not all bidders figure on identically the same thing, from the same starting point? The quantity of work in a job is the same, whichever bidder does it. Why should they not all figure on that quantity? Unless it be that owners want to see who will make the greatest "mistake."

Owner Should Know What He is Getting

On the other hand, is not an owner entitled to know, if he so wishes, what he is going to get, before he binds himself to pay out a large sum of money? If the same owner was about to buy a large tract of land, we will say of irregular shape and grade, he would want every detail and boundary definitely fixed, every corner clearly defined, but this same man, owing to a questionable custom, will sign a building contract for half a million or more, and what does he know about it? or what is he going to get? He has seen a picture of his building, but it is a long, thorny stretch between that and the finished structure, which he expects to get for a certain price. He has seen the drawings and specifications, and perhaps the details. Granting all this, there is still to him a sort of mystery about how the cost of his work is arrived at. He understands very little about it and but few will take the trouble to enlighten him.

If, however, an owner could see some document in real figures, a list of everything that he is going to get for his money, he would be surprised at the quantity of it. He could see that much, and would be far less liable to think that contractors had put up a job upon him and run the cost of his building up unnecessarily. The mass of figures and information that a bill of quantities presents would appeal to him because he could read and understand figures far better than he can read drawings. There should be no mystery about these plain, matter-of-fact business requirements. There is no unsurmountable privacy nowadays in such things; the periods of the trade guilds and accompanying secrets are over, only the traditions remain. This idea of keeping all such information from the owner, which is more or less prevalent, is a false notion, a survival of bygone times. There should be no mystery at all about it.

Quantity Surveying Requires Experience

It would be interesting to know how many, or what percentage of the contractors themselves could, if put to the test, take a set of plans and specifications for a quarter of a million-dollar office building of today, and personally take off all the quantities in detail in each trade and price same correctly without outside assistance. Very few. Yet many private owners think that is what is done, and that is why they expect so much from the contractor. Such work requires training, it is not merely a question of mathematics, as some may suppose. A knowledge of architecture, sound construction, and engineering is essential in a competent quantity surveyor, in fact in older countries many of them are trained architects or engineers before they feel competent to establish themselves as quantity surveyors, but this phase of the subject is something which is very little understood in this country—as yet.

Old customs die hard, but they never died more rapidly than they do in the present age, because it is a progressive age and we are a progressive people, ready to adopt that which is good or more efficient, and to drop that which, owing to modern advancement and science, has become insufficient, and which is the case with our estimating methods, good enough perhaps in the period of tallow candles, but insufficient for to-day. And it is this fact which is largely responsible for the cut-throat practices adopted by bidders themselves, and which have brought the building business of the country into a degenerate condition, so that it is next to impossible for an honest man to remain in the business and pay one hunqred cents on the dollar if he relies upon competitive figuring to get work.

Quantity Surveyor is More Critical

The quantity system possesses many advantages; among others, the professional quantity surveyor is specially trained for this particular work. He is expert in examining and checking drawings, details and specifications, their clearness and accuracy, particularly so from the estimating viewpoint. Occupying as he does an independent position, he can afford to be more critical than any bidder when figuring a job. It is his business, his very training promotes an analytical frame of mind. He is paid for this, bidders are not. Should bidders discover any error or omission in plans and specifications, and they often do, they do not tell other competitors, at least not until after the low man has signed up.

When the quantity surveyor discovers any omission or discrepancy, small or large, it is during the period of his friendly collaboration with the architect himself, and all such matters are then adjusted before the final blue prints are made. Bidders then never see such things as they now sometimes point out.

The object of bidding is to give the cost; the money value in dollars and cents, not the quantity of materials and labor of all kinds. The owner should state what quantity of material, etc., it is that he requires. The only duty of the bidder is to use his judgment and put the cash value on such work as may be submitted to him. It is not his business to figure out quantities, he has neither the time nor the training, and moreover he is not paid to do this part of the work, any more than it is his business to figure floor loads or anything else of that nature.

Saves Bidders' Time

It will be seen, therefore, that in the quantity system there is a considerable saving of waste in bidders' time, and that the drawings and specifications are, after passing through the quantity surveyor's hands, as free from anything which might lead to controversy later as it is possible to make them. This in itself will be found a great help in superintending construction, as many of those vexatious points which now necessarily arise will have already been settled before the contract was let.

Safer and closer bidding will result, with the assurance to the lowest bidder that he is "safe," so far as the quantities are concerned. The bill of quantities should, the writer believes, form the basis of the contract and be one of the contract documents.

Sewage Disposal for Isolated Houses

DURING recent years, many investigations of sanitary methods for the disposal of sewage of isolated houses have been made. The principle upon which the successful treatment of sewage depends is briefly as follows: When the air contained in the soil is brought in contact with dead organic matter in a finely divided state, a complete transformation takes place by the natural processes of oxidation and nitrification. As air is necessary for this purpose, it is essential that the waste be deposited on or near the surface. If the ground is saturated for a long time, purification of the liquid ceases; consequently the principle of intermittent operation of the disposal plant is necessary. The process of applying this principle involves the collection of the material away from the house, the settling out of as much of the solids as posible aided by anaerobic action, and the intermittent application of the effluent to the natural soil by surface or sub-surface irrigation, or to a specially prepared soil as a filter bed.

A water supply is necessary for the collection of the material, and this can be obtained and piped into the house by means of a hydraulic ram operated by a small stream of potable water or by means of a deep well fitted with windmill or force pump.

It will usually be necessary to dispose of the effluent from the settling chamber or septic tank by means of subsurface drainage.

Illustration No. 1 shows a good type of tank for handling the sewage for a family of five and having a capacity of 350 gallons per day.

All sewage coming from the house passes into the settling chamber, where the solid matter to a greater or less extent is deposited. Owing to the character of the sewage, the decomposition of the solids is so active as to prevent any serious accumulation in the bottom of the settling chamber. It is necessary to inspect the chamber from time to time, and if undissolved solids accumulate, to have them removed, probably about once a year. This accumulation should then be carried to the field and spaded into the soil at once.

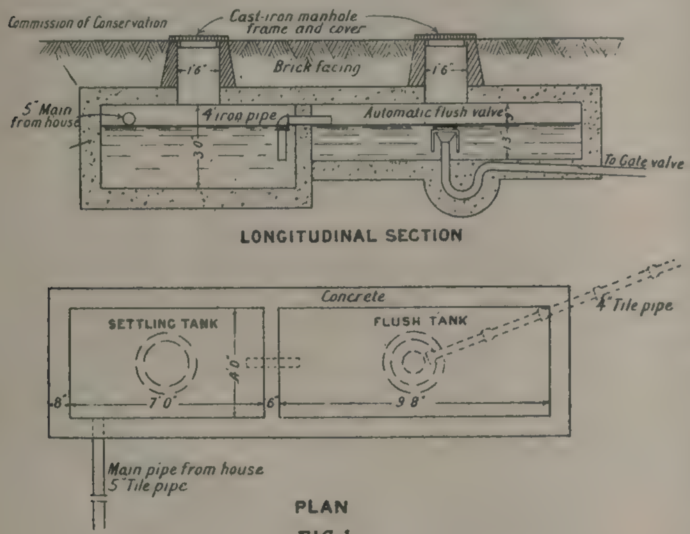

FIG 1

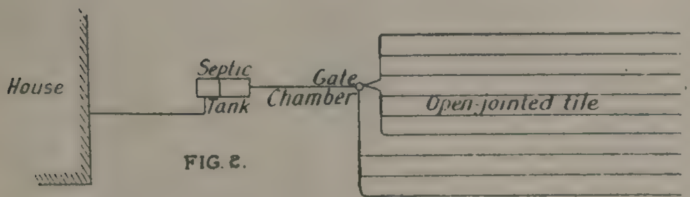

FIG. 2.

Fig. 1—Tank for the disposal of sewage of small family.
Fig. 2—Subsurface drainage for disposal of effluent.

The cost of a tank built of concrete, such as the one shown, will depend on cost of cement, wood for forms, etc., but the cost of all the material, including siphon and cast-iron manhole covers will be, approximately, $60.00. One of these septic tanks was constructed at Aylmer, Que., at a total cost of $63.00.

To secure subsurface disposal, 3-inch agricultural drain-tile are laid with open joints, the bottom of the tile coming within 12 inches of the surface of the ground. These drains should be laid with a slight fall, say two inches per 100 feet. The ground should be naturally or artificially so well drained that water will descend through it readily.

In a country with as severe a climate as parts of Canada, where frost will affect the ground to a depth of four or five feet, it would be necessary to cover the surface of the ground above the tile with straw, leaves or other kinds of mulch in order to prevent the frost affecting it. The superficial area of the disposal plant outlined above would not be greater than 40 feet by 100 feet.

Illustration No. 2 shows a subsurface system adapted to level ground. The tile lines are divided into three series leading from the gate chamber, so that the ground utilized by two lines is given a complete rest while the other is in use. The length of tile required will depend upon the porosity of the soil. For a porous soil, one foot of tile for each gallon of sewage should dispose of the liquid; for clay there should be at least three feet of tile per gallon.—Conservation.

Purchase of Bulk Cement is Advocated

THE Portland Cement Association is inaugurating a campaign for the more extensive purchase of portland cement in bulk. This method of handling cement is urged as being both practical and economical and meaning money saved. Several advantages are accredited to the bulk material. It cuts the cost of financing the job by showing a cost less than for cement in packages by the charge for the package itself and the cost of packing. Bulk cement will be received in better shape, since it is not as liable to damage in transit as cement in sacks. The damage caused by water is not so great with bulk cement as with cement in sacks, as the damage to sacks is prevented. By eliminating the labor employed in emptying, checking, counting, sorting, bundling and shipping sacks, the same working force can turn out more concrete with bulk cement than it can using sack cement. This increase in some instances has amounted to 10 per cent. Miscellaneous expense is reduced as there will be no freight to pay on returned sacks and clerical work in keeping track of sacks is eliminated.

Bulk cement has been successfully used for thirty years. The only trouble is that this method of shipment has not been properly developed. Experience and observation have shown that bulk cement compares very favorably with sack cement as far as dustiness is concerned, and that it reaches the consumer in no worse shape. It cannot reach a job in worse form than a car of sack cement that has been soaked with rain or badly jolted in switching. Projecting nails cannot damage bulk cement. If it leaves the shipping point in good shape, nothing but a wreck can prevent its arrival at its destination in good order.

The equipment for handling bulk cement calls for no more than is needed for the handling of sand and stone. Many contractors are successfully, and at a saving, using bulk cement without any expenditure on additional equipment. The methods of handling are no different from those for taking care of bulk sand, stone or lime.

Sack cement has no place on a job where cement is being used direct from the car to the mixer in quantities exceeding one-half car per day, or at plants making pipe, piles, posts, blocks, tile, etc. An incidental advantage of bulk cement is that it prevents waste by eliminating the cotton, paper and burlap packages which at the present time are scarce and high in price.

The concrete laboratory at Wentworth Institute, Boston, was fitted up in co-operation with the Portland Cement Association and is being used to teach engineers the essentials of concrete work as particularly applicable to military operations, such as the building of gun foundations, bomb-proof construction, etc.

Physical Properties of Pavement Surfaces

After Considering in Detail the Most Desirable Physical Features of Various Wearing Surfaces, the Author Concludes that the Bituminous Sheet Layer is Best

By Chas. A. Mullen*

IT is in their wearing surfaces mostly that modern pavements differ, both as to their physical and their economic characteristics. Indeed, for purposes of comparison, we need hardly consider the foundations at all, for practically every new pavement of a substantial nature is being laid upon a standard six-inch thick and approximately 1:3:6 mixture Portland cement concrete foundation.

Taking up the physical properties of pavement surfaces, we find that they readily divide into two broad classes, into one or the other of which nearly every modern pavement surface will properly classify. These two main classes are the small unit block or brick surface class and the bituminous sheet layer surface class. The latter class is better known as that of the asphaltic surfaces, the bituminous binder used to hold their mineral particles together being in most cases a good asphaltic cement.

The noteworthy exception to the above classification is the hydraulic cement concrete pavement; and the asphalt block surfaces are very much inclined to merge into the sheet layer class under moderately heavy traffic in warm weather. It is often found more satisfactory to repair old asphalt block surfaces with sheet asphalt surface mixtures.

In the first class of surfaces fall the granite block, sandstone block, creosoted wood block, vitrified brick or block, asphalt block, and all other pavement surfaces that are made up of many small unit blocks to the square yard. In the bituminous sheet layer surface class are found sheet asphalt, stone-filled sheet asphalt, asphaltic concrete, asphaltic macadam, and all those proprietary forms of bituminous or asphaltic concrete and macadam that operate under letters patent, copyrighted trade names, and other forms of protection against competition.

The Physical Points

The special features in the wearing surface of a pavement that are most desirable from the physical point of view are the following: Smoothness, cleanliness, sanitation, dustlessness, noiselessness, non-slipperiness, ease of traction, ease of construction, ease of repair and renewal, susceptibility to repair and renewal, susceptibility to constant use, and attractivenesss of appearance. These will be considered and elaborated upon in turn.

Smoothness of Surfaces

The bituminous sheet layer class of surfaces, laid in a continuous operation at a temperature far above that of the atmosphere and then rolled with heavy compressing and surfacing rollers until they have received their initial temperature set, and having no joints except those carefully welded ones that mark the progress of a day's work, are necessarily smoother than the small unit block class of surfaces that are laid by hand, of blocks that have slightly varying thicknesses and that pave many units to the square yard.

In passing quickly over even the smoothest block surfaces in an iron-tired vehicle a vibration or tremor is very distinctly noticeable that is not noticeable at all in passing over well-laid bituminous sheet layer surfaces; and as the block surfaces become older this tremor develops into more and ever more objectionable proportions, until in their last stages it is a positive discomfort to pass over such surfaces on rubber tires, and sometimes even on pneumatics.

Of course bituminous sheet layer surfaces can be so neglected that they become worse than country roads, but there is no possible excuse for such neglect. Any old bituminous surface in reasonable repair is practically as smooth as when new, while with the block class of surfaces the roughness that develops with age is of a general nature not susceptible to any successful repair short of a complete and costly resurfacing with once-turned or recut blocks or with new materials.

Cleanliness and Sanitation

For the reason that they present smooth and jointless traffic areas composed of stone and sand particles cemented together with bituminous cement, the bituminous sheet layer surfaces are the most cleanly. They neither have nor develop a multiplicity of joints and crevices to collect and hold the street dirt, and, being the easiest and cheapest surfaces to clean and keep clean, they are usually found in a more satisfactory condition of cleanliness than the others.

The factors that make for the potential cleanliness of a road and street surface will also operate in its favor with the sanitarian. The same smoothness and freedom from joints that make the bituminous sheet layer surfaces the easiest to clean and keep clean also render them the most satisfactory of road and street surfaces from the sanitary viewpoint. Joints in a pavement surface are but harboring places for filth and germs, and the fewer of them to be found in a given type of surface the more acceptable that type of surface must be considered, other factors being equal, when sanitation is being discussed.

There is but one type of pavement surface that is subject to possible criticism by the sanitarians because of the material that enters into its composition, and that type is the creosoted wood block surface. All others are composed of matter of a mineral nature and are not subject to a breaking-down process that can make them undesirable from a health viewpoint; but the creosoted wood block surfaces, once the saving grace of the creosoting oils has been wholly or partly carried away by the elements operating upon the surface, can be expected to furnish some trouble on this score. We all know how objectionable the old dipped round cedar block pavement surfaces became in their old age, and they did not have to be very old, either.

Cleanliness and Dustlessness Go Together

Cleanliness and dustlessness are partners. A clean street is also a dustless street, and, therefore, there is no excuse for excessive dustiness in our modern cities or on our modern paved highway. Of course, as long as we maintain dirt roadways and unoiled waterbound macadam surfaces on the side streets in our cities we will have dust in unbearable abundance; and there is room for much more care in the regulation of vehicles that to-day seem not at all concerned if they spill a part of their loads along the thoroughfares. But the modern pavement surfaces, unless it be those of concrete pavements without bituminous top dressing, will not create any appreciable dust of themselves, and all are susceptible to economical and thorough cleaning by the power-flushing process.

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The only reason that the bituminous sheet layer surfaces may claim an advantage on the point of dustlessness is that they are easier and cheaper to clean and keep clean than any other modern road or street pavement surface; for, when clean, all the modern pavements are practically dustless.

Bituminous Layer and Creosoted Block Most Noiseless

The entire class of bituminous sheet layer surfaces and the creosoted wood block surface lay claim to being noiseless. The other block surfaces are all open to very serious objection on this score, especially after a few years' wear. Creosoted wood block surfaces are possibly a little less noisy when they are new and smooth than the bituminous sheet layer surfaces, though the difference is of slight degree. The plea for the use of creosoted wood block surfaces upon our city streets because of their noiselessness would be a strong one were it not for the fact that sheet asphalt and stone-filled sheet asphalt surfaces are so nearly as noiseless that the difference could not be worth more than a few cents per square yard, while the latter surfaces have, as elsewhere noted, a tremendous preponderance of other factors in their favor.

Non-slipperiness of Surfaces

The same pavement surfaces that justly lay claim to being the smoothest, cleanest, most sanitary, dustless, and noiseless may be just as surely credited with being the most slippery; and for the same reason of smoothness of surface that gives to them most of the above enumerated virtues. Of course, in fair weather, when all pavement surfaces are dry, none of them are slippery, though the glaze on certain types of brick surfaces when they are new and on certain types of granite block surfaces when they are old and the blocks rounded and polished from traffic are sometimes distinctly annoying.

When brick surfaces are in good condition and the joints not chipped off in the least they are about as slippery in wet or frosty weather as are the bituminous sheet layer surfaces; but, as comparatively few of the brick surfaces that are subjected to any considerable traffic remain for very long in that condition, most of them give a fairly good foothold or tirehold because of the crevices formed by the joints between the small unit blocks.

We may, therefore, safely say that in moist or frosty weather the bituminous sheet layer surfaces, because of a superior smoothness that is in all other respects a virtue, are more slippery than any of the block surfaces except the creosoted wood block, which, rivaling the bituminous sheet layer surfaces to some extent in the matter of smoothness and, therefore, in all the points of virtue growing therefrom, are still, because of their fibrous nature in conjunction with their smoothness, by all odds the most slippery street pavement surfaces known to modern times.

It would seem that this one feature of excessive slipperiness in creosoted wood block surfaces would fully balance the feature of superior noiselessness as compared to the bituminous surfaces.

Smoothness Governs Ease of Traction

The matter of smoothness largely governs the ease with which a load may be drawn over a pavement surface. The bituminous sheet layer class of surfaces would, therefore, seem to afford the easiest traction, and, except in warm weather, there is no question but that they do. However, we must take into consideration the difficulty that is experienced in drawing a heavy load over a standard sand mixture sheet asphalt surface in very warm summer weather because of the sinking of the wheels into the softened wearing surface mixture. The difficulty has no practical existence with the other forms of bituminous sheet layer surfaces except slightly in the most intensely hot weather, for the stones in the bituminous concretes and macadams give them much greater hardness.

But since these bituminous concrete and bituminous macadam mixtures made with large size stones do not withstand heavy city traffic as well as standard sand mixture, many cities have removed this difficulty of the sinking of the wheels into the surface on warm days by the incorporation of from 25 to 30 per cent. of quarter-inch hard limestone, trap rock, or other suitable stone chips into the standard sheet asphalt paving mixture, thereby making what is known as a stone-filled sheet asphalt wearing surface mixture. These stone chips range from one-half inch in their greatest dimension down, and act as a substantial reinforcement to the pavement surface.

The author has never heard of any difficulty being experienced in drawing heavy loads over stone-filled sheet asphalt wearing surfaces in summer, and believes there can be none when the mixture is properly and scientifically proportioned and made, though an unwise cheapening of the mixture would make it soft, as the hardening effect of a full amount of filler is vitally necessary even if expensive.

The smooth block surfaces are, of course, quite easy of traction, becoming less so as they become rougher. A block pavement that is old is apt to be sufficiently rough to present a considerable amount of obstruction to the hauling of a load over its surface.

Bituminous Pavements Easy to Lay

There is no type of pavement surface that an experienced contractor would rather lay than the bituminous sheet layer surfaces. With the block class of surfaces the contractor must purchase the small unit blocks and pay therefor most of the money that he gets for his pavement surface; he must then unload and haul these small unit blocks to the street and there re-unload them and pile them on the sidewalks, after which he must make the bed and lay the blocks in it, roll or ram them, and finally fill the multitudious joints with either a bituminous or a hydraulic cement filler. If it is the latter, he must apply the filling and then blockade the roadway for several days while the Portland cement has time to acquire a firm set.

The difficulty about laying bituminous sheet layer pavement surfaces in very small cities is the expense of moving a mixing plant to the locality of the work, but this can be largely overcome in nearly all cases by an intelligent handling of the matter, arranging to do the largest possible yardage at one time and letting the work in one award to one contractor, so that the cost of moving the mixing plant can be spread over as many square yards of pavement surface as possible and the unit cost be kept at the lowest possible figure consistent with good workmanship.

Ease of Repair and Renewal

When one stops to consider that an asphalt repair gang can travel along a road or street, cut out the defective places, and fill them with new material, roll them and open them to traffic in the space of an hour, in the case of the bituminous sheet layer surfaces, while block surface patches must be slowly and painstakingly fitted in with either new or old blocks, and if cement grout is used for the joint filler must then be blockaded for several days while the Portland cement sets, there does not seem much room for argument on this point.

While the bituminous sheet layer surfaces are decidedly the easiest to repair, they are also much easier to renew than any of the block surfaces. A section of this type of surface can be torn up from street intersection to street intersection and either relaid with the remelted and remixed old materials or renewed with entirely new materials and thrown open for traffic again in the course of a day. The author does not know of any other pavement surface with which this can be conveniently accomplished.

Repair of Cuts

In the case of cuts made through the pavements by plumbers, public service corporations, and city departments to get at the subsurface structures of a street, the bituminous sheet layer wearing surface can be neatly removed in sections of about one-half or one-quarter square yard area and piled carefully at the side of the road or street, and when the work that made the removal of the pavement necessary has been completed, the concrete foundation can be restored, and these sections fitted back into place upon the wet concrete, the joints plastered up with the surplus mortar from the concrete, and the patch opened to traffic as soon as the concrete foundation thereunder and the mortar joints have had time to set sufficiently, which is but a few days.

The author has seen repairs of this type made and has known them to last for years on streets of moderate traffic, until, in fact, they were finally taken up and repaired in the usual way to remove the unsightliness of the cement joints that offended the sensitive natures of some abutting property-owners.

Susceptibility to Repair

It has often been said that a brick pavement is new until its surface has once been patched, then it is old. This is equally true of creosoted wood block surfaces. Satisfactory repairs cannot be made to either of these block surfaces unless the work is done as an exceptional case and at great expense. Satisfactory repairs can be made on granite block and sandstone block surfaces if reasonable care is taken in fitting back the blocks and filling the joints with Portland or bituminous cement.

As any reasonably efficient asphalt patching gang can repair a bituminous layer surface on a street where there is sufficient traffic to weld the joints, in such a way that it is quite impossible to find the patch several days later, it is obvious that this class of surfaces, especially the sheet asphalt, is the most susceptible to repair because of the quickness with which the operation can be accomplished, and the sameness in appearance between the renewed surface and the old surface where they join at any point.

Susceptibility to Use

This depends upon the time required to lay, repair, and resurface a pavement, and the necessary frequency of the repairs and renewals. A bituminous sheet layer surface can be either patched or renewed in less time and with less interference with traffic than any other surface.

In the matter of the frequency with which repairs and renewals will be required in comparable cases it is difficult to point to any definite difference between the creosoted wood block, the vitrified brick or block, and the bituminous sheet layer surfaces. It is the author's opinion that creosoted wood block and sheet asphalt surfaces will about balance honors in this respect, and leave brick in second running. Granite block undoubtedly leads by a safe margin, with sandstone block a tardy second.

Granite block surfaces with tar and gravel joints and bituminous sheet layer surfaces of the sheet asphalt variety will probably divide honors evenly in the matter of their susceptibility to constant use, the granite block surfaces requiring less frequent repairs and renewals and the sheet asphalt surfaces requiring considerably less time for the actual making of the repairs and renewals.

In this connection it is fair to mention that, as the granite block surfaces and the vitrified brick surfaces become aged, usually for quite a period preceding their removal and renewal, they can hardly be said to be susceptible to very considerable use, for traffic will go out of its way to avoid them because of their roughness. This is not true of the bituminous sheet layer surfaces, which even in their old age can easily be kept in a condition of smoothness that will be satisfactory to all kinds of traffic.

Attractiveness of Appearance

Some block surfaces look very well when new, and have even been referred to at such times as artistically resembling mosaics. New block surfaces are not unpleasing to the eye, but as the newness wears off the attractiveness ceases to be. As soon as the joints between the blocks begin to open up a little or repairs have to be made, the block pavement surfaces are no longer in any sense attractive. This is particularly true of creosoted wood block and vitrified brick surfaces, and somewhat less true of granite block and sandstone block surfaces.

To the author's eye, which he believes is an average organ of sight sensation, the bituminous sheet layer surfaces are far more pleasing than the block surfaces. But of far greater importance than just their original attractiveness is the fact that the bituminous sheet layer surfaces, if kept in reasonable repair and reasonably clean, do not lose any of their attractiveness with age, as do the block class of pavement surfaces in spite of good care.

It would seem to the author from the foregoing statement of the facts in relation to the physical properties of the several pavement surfaces in general use on city streets and rural highways that any one of the bituminous sheet layer surfaces surpasses each of the block surfaces in the desirable physical properties when all the physical points of advantage are considered collectively.

Accidents on Construction Work

Fifty Per Cent. of Accidents are Preventable—Practically No Enforced Safety Precautions — What It Costs for Protection

It is cheaper and better in every way to prevent accidents than to pay for them. This is quite as true for the employer as for the employee, for, although the latter suffers the pain, the employer pays compensation, loses the services of a skilled laborer for a period, loses the profit on the man's work and in general has his organization disarranged. Therefore, every accident prevented is added profit.

In an article apearing in the Engineering News-Record on June 7, Mr. J. J. Rosenthal, safety engineer to the Industrial Accident Commission of California, tells of accident prevention possibilities on construction work in that state. He calculates that fifty per cent. of construction accidents are preventable, which in his own state would mean a saving to employers of about one and three-quarter million dollars a year. The article is full of valuable information and suggestions and is reproduced below:—

Although much attention has been devoted to accident prevention on railroads and in manufacturing industries, practically no safety precautions have been enforced on construction work. There seem to be two reasons for this lack of attention: That the work is of a temporary character and that the worker is injured in most cases by falling or being struck by some object falling from above.

From the standpoint of the safety expert, construction work can no longer be classed as a temporary industry. Safety precautions are necessary and are applicable regardless of the duration of the construction period. The worker can be protected in large degree from the danger of falling by the provision of substantial scaffolds, stagings and flooring, at the same time that similar safety measures can afford him sufficient covering to protect him from objects falling from above.

Safety Laws to Govern Construction

California is pioneering in the enforcement of safety regulations in the construction field. Three years ago, with the advent of the Workmen's Compensation Insurance and Safety Act, it was required that all places of employment indoors or outdoors, above or below ground, should be made safe. The Department of Safety of the Industrial Accident Commission has engaged in a vigorous campaign to carry out the provisions of this Act, and an organization has been developed for the inspection of construction work and the investigation of accidents that occur during its progress.

An analysis of accidents in connection with this work has led to the compilation of the accompanying accident table, covering all classes of construction work. The table shows a considerable reduction in the number of accidents in 1915 and an increase in 1916. This is because 1914 and 1916 were marked by greater construction activity than the intervening year. Comparing the figures for 1914 and 1916, however, shows the actual reduction of accidents which can be attributed to rigid inspection and the adoption of methods for safeguarding the worker.

TABLE SHOWING INJURIES SUSTAINED ON CONSTRUCTION WORK IN CALIFORNIA

Class of Accident (See note below)	Fatal			Serious			Slight		
	1914	1915	1916	1914	1915	1916	1914	1915	1916
A	50	34	40	19	16	15	1,635	1,652	1,678
B	72	47	60	166	146	161	3,415	2,225	2,769
C	17	13	12	11	16	15	5,359	6,988	6,040
D	14	12	13	29	23	26	91	164	141
E	12	12	11	13	9	11	763	987	904
Totals	165	118	136	238	210	228	11,263	12,016	11,532
Grand Totals		419			676			23,279	

Note Class of accident is as below:

A. Injuries resulting from the lack of shoring and bracing of tunnels, trenches, excavations or sheeting or sheet piling of treacherous ground.

B.—Injuries resulting from the collapse, tipping or falling of scaffolds, stagings, ladders, walls, and all false work, due to inadequate support, flimsy construction or defective lumber or overloading of same. Included in this group also are injuries resulting from falls into unguarded floor openings, elevator shafts, or due to lack of flooring in buildings or other structures in course of construction. (Nine of the accidents listed were due to pile drivers and bulldozers in 1914, and 18 similar accidents occurred in 1915).

C.—Injuries resulting from the falling of material which has been previously piled or which is in the course of being piled and which falls due to improper foundations or due to being improperly piled.

D. Injuries due to careless storing or handling of explosives.

E.—Injuries resulting from the overloading or overstraining of ropes, cables, or slings which are used in all class of hoisting apparatus, such as derricks, cranes, etc.

From the average amount paid for compensation and medical fees per accident, it is computed that the 419 fatal accidents for the three years cost $460,900; the 676 serious injuries, $498,043; the 34,811 slight injuries, $811,096.30, making a total of $1,770,039.30. The slight injuries resulted also in the loss of 591,787 days. Converting these figures into 300-day years gives a total loss of 1,972 years. Assuming the average annual earnings for each man as $900, the loss sustained by these men amounted to more than $1,750,000.

Half the Accidents are Preventable

It is the general opinion of the engineering profession that half of the accidents which occur are preventable. If the compensation and medical fees alone could have been reduced 50 per cent., $885,019.65 would have been saved to the employers of California in the past three years. Then, too, if one-half of the accidents were preventable, 210 lives might have been saved and the wage earners in 210 families would still be at work providing for those dependent on them.

Adequate safeguarding would also reduce the rate on compensation insurance premiums which under present conditions is exceedingly high, just as fire insurance is materially reduced for those who take steps to safeguard against fire. Most of the accidents represent a great economic and social waste, for the cost of safeguarding is very slight.

Detailed Costs of Precautions

To give some illustrations: The twelve-storey Santa Fe building recently constructed in San Francisco, a structure 45 x 90 ft., costing $350,000, involved the following costs for safety measures: Five temporary floors used by the steel erectors, to protect them from falling and as a protection from falling materials, at $111.76 per floor; twelve double ladders at $1.50; 135 ft. of suspended safe scaffolding, used by bricklayers, at 33 cents per foot; a 5 x 5-ft. tower, 196 ft. high, with cage for hoisting materials, at $1.25 per foot;

guarding 24 openings, 6 x 14 ft., for elevator shafts and stairways, with railings 3 ft. 6 ins. high, at $1.50 per foot; 135 ft. of temporary enclosed sidewalk at $1 per foot.

The total cost of safeguarding 175 workers who were engaged in building this structure for a period of six months was $1,032.35, or $5.89 for each worker. If a fatal accident had occurred to a laborer it would have cost the contractor $2,700 for compensation; or if a mechanic had been killed, it would have cost $5,000. These sums of money represent only the economic loss. They would not pay for any life, nor relieve the mental sufferings of those dependent upon the worker. Past statistics show a fatal accident for each storey above the tenth on a building over ten storeys high. On the Santa Fe building, however, there was neither fatal accident nor permanent injury and only one slight accident.

Taking an example from another class of construction: A sewer system involving 30½ miles of 8 to 30-in. vitrified and concrete pipe placed at depths from 5 to 18 ft., and costing $250,000, was completed at Stockton and Hanford by Chambers & Heafey, general contractors. The cost of bracing, shoring and sheeting this work was $12,000. About 3,500 men were engaged on this work for a period of twelve months, and no fatal accident or permanent injury occurred and there were only a few slight injuries. Such results as these are accomplished through careful and frequent inspections by safety engineers and co-operation of employers and employees.

Contractors' Carelessness

Considerable difficulty has been met with in inducing contractors to safeguard construction work. There seem to be several reasons for this. First, the keen competition in bidding causes contractors to disregard calculations for safety in order to offer the lowest bid. Such employers object to the expenditure of any money for safeguarding on the ground that they did not figure on it in their bids.

Second, the constant changes in the nature of the work as construction progresses make each stage so temporary that the contractor is tempted to evade safety provisions such as bracing and shoring excavations and providing rigid scaffolds, falsework, etc. He argues that it does not pay for such a short time. Third, the speed and high pressure under which most construction work is carried on cause the contractor to avoid anything which seems to him to retard the progress of the work.

Fourth, the workmen themselves are often averse to bothering with safeguards. In their impatience to get ahead they will often use weak material because it happens to be nearest at hand. The writer has seen the use of six-penny nails instead of 20-penny nails, 1-in. boards instead of 2-in., defective lumber used on scaffolds and falsework, and general experience in California bears out the truth of the statement that 50 per cent. of accidents can be prevented.

Serious Accidents on the Decrease

On the whole there has been a considerable decrease in serious and fatal accidents on construction work in California since the safety department began its "Safety First" campaign. Contractors are realizing that it pays. For example, when a scaffold or any falsework collapses there are five distinct effects: (1) The direct injury to the person or persons who fall; (2) the psychological effect on the workers who witness the accident and loss of efficiency therefrom; (3) the delay due to the temporary cessation of work and the necessity of rebuilding the structure; (4) increased cost of the work and the compensation and hospital fees of the injured; (5) the increased cost of insurance if such accidents occur repeatedly or a big loss if not insured. Much has been done in this field in California but there is still much to be done in the way of educating both the employer and the employee in the "Safety First" movement.

The New Safety Orders

In line with its policy of extending supervision to all fields of construction, the Department of Safety of the Industrial Commission last year undertook to draft a safety code which would effectively cover the construction field. At first there was prepared a tentative draft of general construction safety orders. This was submitted to a committee in San Francisco composed of representatives of engineering organizations, the general contractors, architects, board of public works of the city, and the Building Trades Council of the state. After being passed upon by this committee, the orders were referred to a similar committee in Los Angeles. In revised form, but before final adoption, they are now being sent to contractors, engineers and architects throughout the state for criticism and suggestion. The ultimate purpose is to have the safety orders embodied in a state law.

Meantime, the draft of the safety orders in the present form is being enforced by the commission. If any employer considers the provisions unreasonable he may petition the commission for a hearing, after which if the order is found to be unreasonable, the commission is required by law to substitute such other order as may be deemed just and equitable.

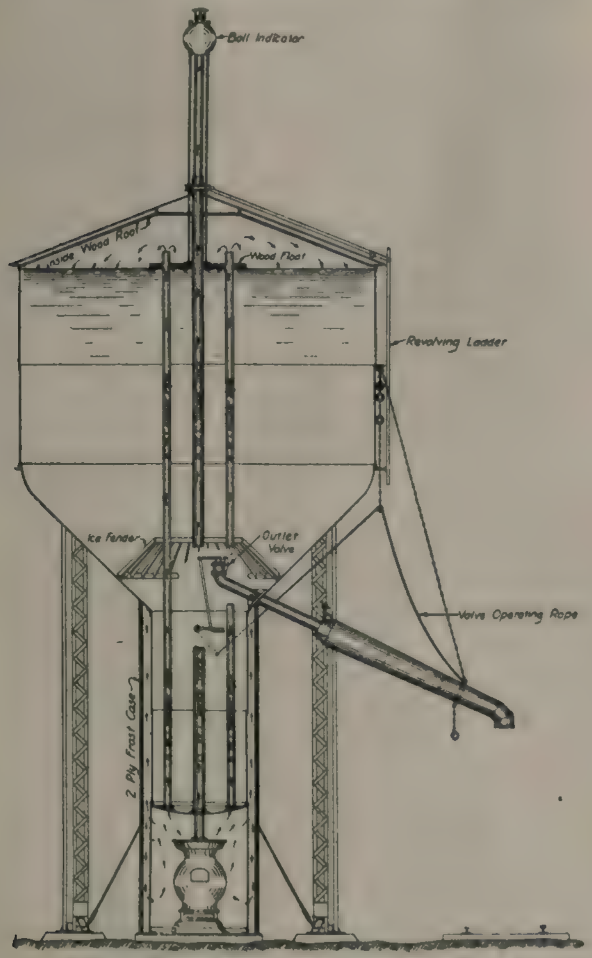
As now revised, the safety orders cover all branches of construction, with detailed provision for safety measures that must be observed on each class of work. The orders require the protection of workmen in trenches, on scaffolds, when working underneath superstructures, and the use of temporary floor planking and safety nets in structural work and the guarding of openings between floors. Detailed attention is given to the methods in which workmen may handle explosives, the demolition of buildings, the piling and storing of materials, and in fact wherever personal risk is involved.

Water Tanks for Winter Use

THE water tanks used by our Canadian railways require to be heated during the extreme winter weather to prevent damage from frost. The wooden type of tank which is still quite common, must be enclosed in a substantially built house and heated. Owing to the wooden construction, the danger of loss by fire is always present. Within recent years steel tanks with heating arrangements have become more common. The illustrations herewith show a type that has been developed to withstand extremely cold weather. Many of these tanks are in use and it is said that a temperature of 60 to 70 degs. below zero can be successfully withstood.

In the tank illustrated, a heating chamber is provided in the lower part of the riser pipe by raising the head plate about 7 ft. from the foundations. This leaves ample room for a good sized heating stove, which is connected to an 8 in. flue which runs directly up through the centre of the tank and out above the apex of the roof. In order to confine the heat around the water contained in the riser, a frost casing of wood, brick or concrete, is built around the riser, so as to leave a 6-inch air space between the inside of the case and the outside of the pipe. Large holes are cut in the lower part of the riser pipe to facilitate circulation of the heat in this air chamber. The stove in this way concentrates the heat not only underneath the water in the riser pipe but also around its entire periphery.

Two 6-inch heater pipes from the head plate to slightly above the high water level, carry superfluous heat to the top of the tank. This prevents ice from forming over the surface of the water. In order to prevent any ice that might accumulate from slipping down into the drum and causing damage to the valves and service pipes, an ice fender is provided over the top of the riser pipe. With this arrangement, even though the water is allowed to get low in the tank, nothing can fall down on the outlet valve and damage it or prevent it from operating successfully.



A type of railroad water tank designed to withstand extreme winter weather

In the type that is illustrated, the outlet valve is operated by a mechanism located inside the riser pipe. Damage by ice, often experienced with the usual method of operation with overhead levers, is prevented. The operating mechanism of the outlet valve being close to the heater pipes and smoke flues, is kept in good working order.

Tanks of this type have operated successfully under very extreme temperatures. As an example of their effectiveness, the instance of one tank may be cited, which withstood the effects of frost for 39 days in succession when at some time every 24 hours the temperature was at least 30 degs. below zero, and one day as low as 70 degs. below zero.

Keeping Reinforcing Bars in Position

THE holding of reinforcing bars in proper position while concrete is being placed is a matter which merits the utmost attention. The labors of the best designer and detailer can be set at naught by the carelessness of those in charge of the construction of reinforced concrete structures, while placing steel and concrete.

A designer spends many days designing and detailing a complicated structure, the strength of which can be greatly impaired by comparatively slight displacement of the reinforcement at critical sections. Much time is spent in designing and detailing the reinforcement for a structure, and the all-important matter of getting and keeping the bars in correct position is disposed of by a single note, such as the following: "All reinforcement to be bent and placed as shown on plans and to be securely fastened or tied to prevent displacement during pouring of concrete and to insure proper position of reinforcement in the finished structure." It is left to the discretion of the construction foreman to devise a means of keeping the bars in position, and as a result the strength of the structure may depend on whether the foreman thoroughly understands his business or not.

This is neither good practice nor economy. The method and means of supporting reinforced bars should be clearly indicated on the plans, since they are as important details as the location of bends of bars and stirrups. It is just as important to show the supporting bars, supporting blocks and clips, and the spacing bars as it is to show the main reinforcement in detail. Before the structure can be built it is necessary for someone to devise a means for keeping bars in position during construction, and, as a general rule, a good designer is more capable of handling these details to good advantage than anyone else.

Glue Molds for Concrete

Multiples of small concrete ornamental members like ballusters, handrails, etc., have been advantageously cast in moulds made of ordinary glue. The wooden pattern is nailed to a board and enclosed with shallow sides making an open box higher than the pattern which is filled with melted glue covering the pattern to a depth of about an inch. After the glue is set it is turned bottom side up and the bottom and pattern removed, leaving a mould which is painted with white lead followed with shellac to prevent the absorption of moisture.

The mould is good for a large number of castings and can be cut up, melted, and used over again with a loss of about 18 per cent. It is very tough and rubbery and should be cut with a knife into about 1½-in. cubes which will melt in three or four hours.

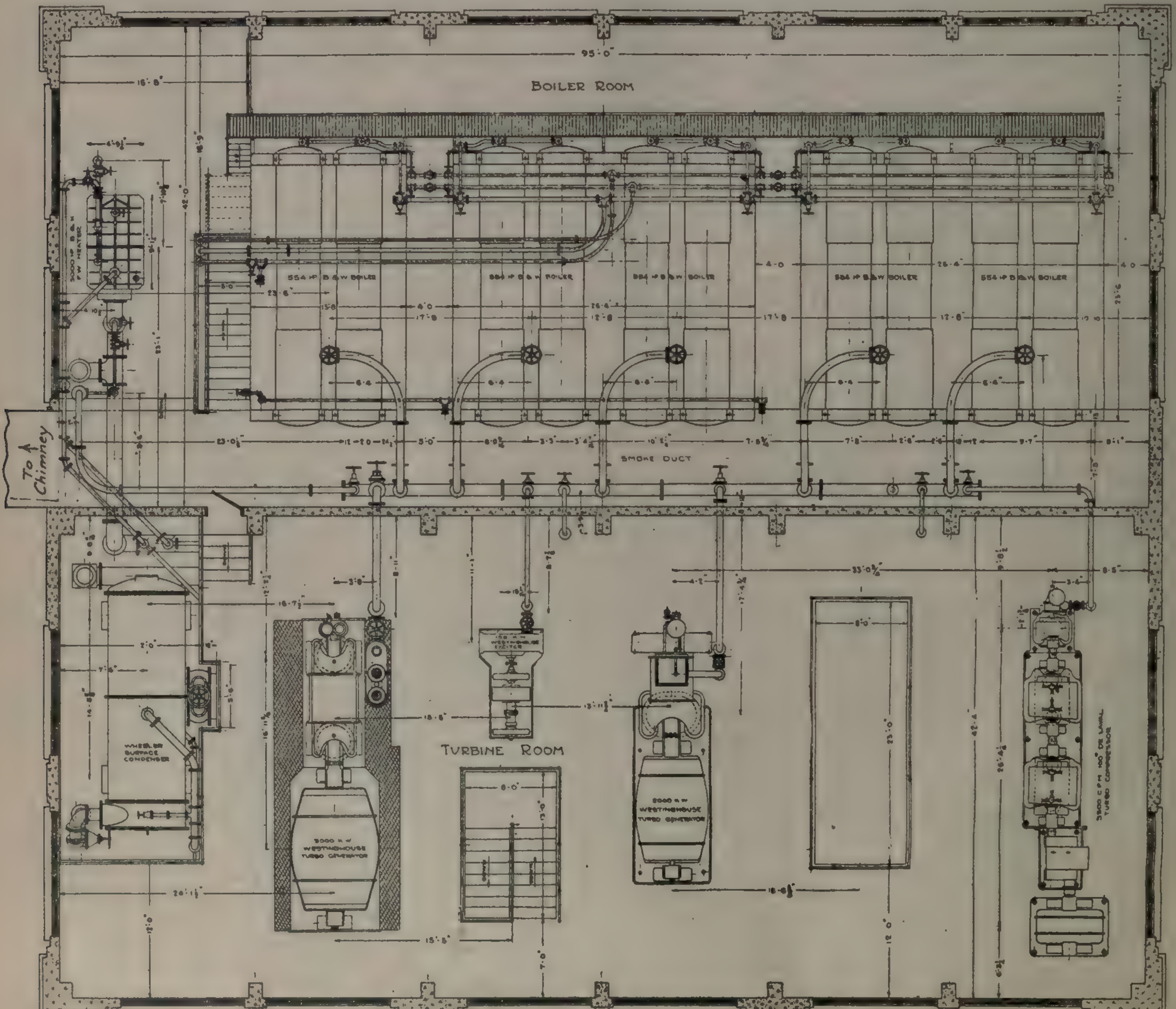
The town of St. Lambert, P.Q., has awarded a contract to Laurie & Lamb, Montreal, for a 1,300 U. S. gallon (per minute) centrifugal pump, manufactured by the Lawrence Machine & Engine Company.

Steam Power Plant of Granby Consolidated Mining, Smelting & Power Co., Ltd.

THE Granby Consolidated Mining, Smelting and Power Company, Limited, have recently constructed at Anyox, B.C., an auxiliary steam power plant, at a cost of nearly $500,000. The power house is a reinforced concrete structure, approximately 100 ft. x 90 ft. x 37 ft. high, in which are installed five 550 h.p. water tube boilers, designed for a working pressure of 200 pounds and 150 degrees superheat. These boilers are served by a continuous brick smoke duct, entering the base of a Custodis radial brick chimney 10 feet in diameter and 150 feet high.

In the boiler room is installed a 3,000 h.p. Blake & Knowles open feed water heater, two Worthington oil-burning sets, and two De Laval centrifugal steam turbine-driven boiler feed pumps, each having a normal capacity sufficient to take care of the entire plant.

In the turbine room is installed a 3,000 kw. Westinghouse turbine-driven, 3-phase, 60-cycle, 2,200-volt alternator, the turbine exhausting to a C. H. Wheeler surface condenser; one 2,000 kw. Westinghouse turbine-driven generator, the turbine exhausting to a Westinghouse Le Blanc jet condenser; one 100 kw. Westinghouse turbine-driven exciter exhausting to a feed water heater. In the turbine room is also installed a 3,500 cubic foot, 100 pounds pressure, De Laval centrifugal compressor, consisting of fourteen stages, and arranged to be driven at the one end from an 800 h.p. De Laval turbine without reduction gears, and at the opposite end by an 800 h.p. Westinghouse 2,200-volt induction motor operating through De Laval reduction gears. This unit is the first high-pressure centrifugal compressor to be installed in Western Canada, and it is a particularly interesting piece of apparatus apart from the fact that it is arranged for two forms of drive, one to be used when the steam plant is in operation and the other when the water power is adequate to



Plan of steam power plant of Granby Consolidated, Anyox, B. C.

furnish current for the electric motor, which will be during the summer months.

The 800 h.p. De Laval turbine is arranged to exhaust to a Schutte and Koerting jet condenser. The entire turbine room floor is served by a 15-ton hand-operated travelling crane. Circulating water for condensing purposes is supplied by two 12-inch De Laval centrifugal pumps, each directly connected to a 125 h.p. Westinghouse motor. Each pump has a capacity of 4,000 gallons per minute against a total head of 70 feet, and either unit is capable of supplying the full requirements of the plant.

The high-pressure steam piping has all been designed for a pressure of 230 pounds and 150 degrees superheat, and the main steam header is of cast steel, and a particularly good piece of work. All steam piping was supplied by Crane Company, Vancouver. The plant is intended to serve the operation of the company during the periods of low water, and it is believed will be in operation for about six months of the year.

In connection with the plant is a fuel oil storage system, consisting of a steel storage tank 90 feet in diameter by 30 feet high, having a normal capacity of 35,000 barrels. Oil is received at the company's dock and pumped through about 1,400 feet of 12-inch diameter pipe to this tank. In the tank is installed a heating coil of special design. Adjacent to the tank is a small concrete pump house, in which is installed a vertical boiler, which supplies steam to the heating coil, and an electrically-driven rotary oil pump delivers oil from the tank through about 900 feet of 6-inch line to an auxiliary tank buried underground at the power house.

The plant was erected in a comparatively short space of time, as the company did not proceed with the construction until June, 1916. The design of the plant was under the direction of Mr. F. M. Sylvester, vice-president and managing director of the Granby Consolidated Mining, Smelting, and Power Company, and the work has been carried out by the Taylor Engineering Company, consulting construction engineers, Vancouver, B.C.

Refuse Destructor Clinker Successfully Used for Roadmaking

By J. G. Carey, A. M. Inst. C. E.*

WHEN the writer succeeded to his present position in 1906 he was faced with the necessity of building up several roads in the district, and decided to utilize refuse destructor clinker, which had hitherto been considered a waste product. The method adopted was to scarify and throw out the road surface, spread the clinker, roll to shape, and resurface with the old and new material as required. The results were very satisfactory, for, although in the rolling a considerable quantity of the clinker was reduced to powder, the material proved equally as hard and tenacious as brick or stone rubbish.

From 1906 to 1910 clinker was used for roadmaking, and for filling filter beds at the sewage works. The material was mixed with tar also for patching roads, and as a bottoming for tar-paving. In 1911, and again in 1915, clinker was used for bringing to a level certain school sites, and in addition tarred clinker was used as a bottoming for the tar-paved playgrounds.

Satisfactory Results

In 1913 the council was so satisfied with the results obtained by the use of tarred clinker that a small mixer was purchased with a view to making further use of the material for roads and footpaths. Up to 1915, with the exception of the material used for the schools, tarred clinker was mostly used for tarpaving and road patching. This was largely due to the extensive road and other contracts then in hand, which prevented any time being given to the production of the material. With the cessation of contracts in the spring of 1915 a sufficient quantity of clinker was manufactured to enable Holloway Street, Hounslow, to be resurfaced. This road is a cul-de-sac, without any traffic of importance, and was chosen to allow the men an opportunity to become accustomed to the handling of the material.

By the spring of 1916 the stock of tarred clinker had again accumulated, and the county engineer and surveyor, Mr. H. T. Wakelam, M.Inst.C.E., was asked to co-operate in the experiments; he readily consented, and obtained sanction to carry out experimental resurfacing works with clinker asphalt on the county main roads within this district.

The object of the proposed experiments is to demonstrate whether or not clinker obtained from refuse destructor and stored in a large heap until nearly burned out can be utilized in its varying grades, from impalpable powder to a large size, for the manufacture of a road surface material which will stand the test of time. Experiments with clinker have been carried out in recent years by Messrs. Lovegrove, Hornsey; Wood, Fulham; Roberts, Worthing; and Angell, Beckenham, with great success. The experiments in Heston and Isleworth, which, it was hoped, would have been completed last year, have unfortunately for various reasons had to be postponed for a time; when proceeded with it is further hoped that the experiments will be on a line in advance of what has hitherto been carried out.

Staines Road Experiments

In June, 1915, the county and ourselves agreed to terms, and a contract was let to the Trinidad Lake Asphalt Paving Company, Limited, for the following experimental lengths of asphaltic macadam, to be laid along the Staines Road, which is, in fact, the main road through the district to Aldershot, Southampton, and the West of England.

Section 1.—Approximate area, 2,250 square yards. The company to supply and lay 1¼-inch bituminous clinker wearing surface, on a tarred clinker foundation to be provided.

Section 2.—Approximate area 2,250 square yards. The company to supply and lay a mixture 1¾ inches thick of bituminous clinker and sand-wearing surface on a tarred clinker foundation to be provided.

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*Extract from paper read at the Institution of Municipal and County Engineers.

Section 3.—Approximate area 5,000 square yards. The company to supply and lay 1¼ inch thick of Standard Trinidad Lake asphalt wearing surface on a tarred clinker foundation to be provided.

Section 4.—Approximate area, 1,000 square yards. The company to supply and lay direct upon the existing roadway a single coat of bituminous clinker and Kentish rag, 2 inches thick.

In connection with Sections 1, 2 and 3, the contract includes the maintenance of the pavement laid for a period of ten years from the date of completion. Section 4 does not include maintenance, but should this prove successful, the benefits to be derived from it will be greater than those obtained from Sections 1, 2 and 3.

The work involved in section 3 was commenced on August 17, 1916, but perforce had to be discontinued on August 24, 1916, the area covered with Trinidad Lake asphalt during that time being 1,470 sq. yds.

The reason for the discontinuance of the work was owing to the fact that the clinker was found to contain an excessive quantity of tar, which caused too much flexibility in the foundation for the topping, and cracks resulted therefrom. This was proved by the fact that the asphalt surfacing appeared to be more successful where the clinker bottoming obtained from the skirts of tarred heaps had been used. The latter had to be matured to a great extent by reason of its being in direct contact with the atmosphere.

The Mixing Process

In September last it was decided to discontinue cold mixing and to install a combined drying and hot mixing plant. Terms were agreed with the contractors for the hire of the plant, and it was anticipated that the latter would have been erected and the work resumed last year, but, owing to the Ministry of Munitions retaining the plant until recently, the work connected with its erection is only now proceeding.

In recommending the council to install the new plant the factors deciding the installation were as follows:

(1) The storage heap was burning for 75 per cent. of its area on March 18th, but ceased during August owing to the heavy and continuous rains which fell during that month.

(2) The inability of the refuse destructor to supply sufficient clinker during the summer months.

(3) The hot mixing of the material would lessen the amount of tar required, and it is hoped that it will also admit of a lesser thickness than 4-inch consolidated bottoming being necessary.

It may be here mentioned that the ingredients for cold mixing were as follows: 1 cubic yard broken clinker, 12 gallons of tar (to specification), 7 lbs. pitch.

(4) The provision of a drying and hot-mixing plant would be of great value to the council owing to the fact that it would admit of uniform results being obtained. Further, it would afford precise information as to the capabilities of the plant to deal with either larger or smaller quantity than can now be obtained by the present methods.

When the work of laying the Trinidad asphalt ceased, about 1,500 square yards of uncoated tarred clinker bottoming remained, which it was decided to coat in two sections, the tarred granite and tarred limestone chips. Unfortunately, the results have not been satisfactory, which was mainly due to the exceptionally heavy rains which fell and penetrated the material whilst it was being laid.

Co-operation of Engineers for Recognition

Address Delivered at Convention of American Association of Engineers Impresses the Need of Solidarity and Unity Among Technical Men

By G S. Williams

TO one who reviews the status of engineering in America to-day, it presents a somewhat anomalous aspect. Owing to the wide differences in technical standing of those who are its devotees, it appears at one glance a profession and at another a trade. At one end of the list are some thirty thousand members of the national engineering societies, which represent the elite, the aristocracy. Next them stand the membership of the state and local societies and the waterworks associations, which add probably sixty thousand more; and back of and beyond these are the draftsmen, instrument men, inspectors, chain men and rod men, probably at least a hundred thousand.

On account of this varied make-up engineering appears in a markedly different situation from the law, medicine, or the clergy. Among these three learned professions it is rarely indeed that a member in the lower ranks is employed by any but a member of his own profession, and, however employed, the professional independence of the employee is rarely transgressed; but in engineering it is relatively few who are masters of their own performances, and many of them are directly employed by and report to men who are not themselves engineers and who, therefore, take little interest in the advancement of engineering.

This condition of affairs militates strongly against that solidarity which is essential to such a recognition of the engineer as the importance of his work would warrant. The young engineer oftentimes feels nothing in common with those higher up in the profession beyond the fact that both he and his superiors for several grades above him are working on salaries for the same employers, in whose estimation engineers are probably merely instruments of service to be taken up or laid aside as business exigency or individual caprice may dictate. In spite, however, of these handicaps the recognition of the engineers has steadily increased, though not so rapidly as we would wish.

Improving the Status of Engineers

What can we do to accelerate that recognition to which we believe the engineer entitled? For answer we must enquire whence is the recognition to come. If it be from the general public, then it is a question of advertising; if it be from the governing bodies of our municipalities and states, then it is a question of votes.

In the past engineers have sought only the recognition of the few who by their own attainments were qualified to judge the merits of the work of their fellows without the intervention of an advocate. The assistant has been content with the approval of his chief, and the chief with the approval of his fellow-engineers. It is seldom that the public has been taken into confidence.

The man who conceives, who dreams the dream, is of vastly more importance and value to the world than he who merely makes it a reality. It is ideas that are needed—there are plenty who are ready to execute them. So the greatest in engineering are the designers, those who conceive and produce that which has not been conceived or produced before.

The time has come when recognition must be given both to dreamer and to the builder. Those who have made possible the present condition of human existence, upon whom the world depends for its morning meal and its evening light, for its daily news and its weekly bath, are entitled to the acknowledgment of the debt of their fellows owe, and they must get it. The answer to the query "How?" is in the one word, "Co-operation."

When, a decade ago, arrangements were completed by which three great national engineering societies were brought together under one roof, the first great step in engineering co-operation was taken; and when, after ten years of "watchful waiting," the parent society of them all has joined its offspring, co-operation in engineering may well be looked upon as established. But the national societies, although they include in their membership several thousand young engineers, nevertheless represent the aristocracy of the profession and never in any way reach or supply the needs of those who make up the vast numbers dependent upon engineering for their livelihoods, but who have not yet reached that condition where they can maintain themselves by independent effort.

Societies Hesitate to Make Radical Changes

Like all aristocracies, the national societies are conservative. Being composed of, or at least controlled by, those who have achieved their successes under existing conditions they naturally hesitate at any wide departure from past custom and experience. Furthermore, they are not closely in touch with those who may be said to compose the rank and file of their profession, and therefore do not know to what extent the latter will support such efforts as they may make.

The American Medical Society has built up the most complete and best-organized system of co-operation yet developed in this country. Starting with the county medical society as the unit, to which every practitioner in the country is supposed to belong, there next comes the state medical society, to which the county societies send representatives, and this, in turn, sends its delegates to the American Medical Society. The process is simple, the attainment complete. Every physician in the country is thus within call of the head of the organization in the national society.

For the engineer, inasmuch as the state societies are rarely as strong as some of the local societies within the same territory, it does not seem necessary to go from the local to the national organization by way of the state society as an intermediary, but more rational to unite all national, state, and local societies in a combination, to the governing body of which each would send delegates in proportion to its membership.

The national societies have in embryo an organization well adapted to this purpose in the Engineering Council, and if they can be brought to see the advantages to come from an extension of it beyond the limits of their own membership, there should be little difficulty in gathering into the combination the ninety thousand more or less engineers now affiliated with the national, state, and local societies, and we would then come to that great army of more than equal size which until recently was wholly unorganized and among whom the American Association of Engineers has its greatest field. This organization, in which I am proud to be recorded a member, stands before you as the embodiment of the democracy of engineering, with a representation in every state and important city in the union, and a membership of eighteen hundred and fifty acquired in less than two years of existence.

Promoting Engineering Welfare

The American Association of Engineers announces as its objects: "To raise the standard of ethics of the engineering profession and to promote the economic and social welfare of engineers," and in pursuance of these principles has sounded the watchword of co-operation. It has begun by making itself useful to those most in need of its assistance, and has gathered to its standard a membership largely composed of those whose names are unknown to the rosters of other societies and has laid a foundation large enough and broad enough for every engineer to stand upon if needed.

But we should look to the national societies to take their place as leaders in bringing about complete co-operation of engineers. The charge has been made that the proposed engineering council is undemocratic, but no one can say it is unrepublican. In a body so large as the national societies, and so large as this society will soon become, government by conventions will be a failure; it must be entrusted to representatives; and in order that each member may have a voice, the elections of those representatives must be by letter ballot.

If the national societies fail to meet their responsibilities; if, after a reasonable time, they do not work out a plan of co-operation involving the utilization of all engineering forces of this commonwealth, then it will be time to turn to other agencies; and the possibilities of this association will be entitled to the most serious consideration.

Personal Service to the Public

The American Association of Engineers is not a trade union. While it contemplates rendering actual service to its individual members, it also contemplates and insists that its members shall render service to it and to each other. For him whose only query is, "What do I get out of it?" there is but scant place; but for him who asks, "What can I do to assist my fellow-engineers?" the doors are wide open.

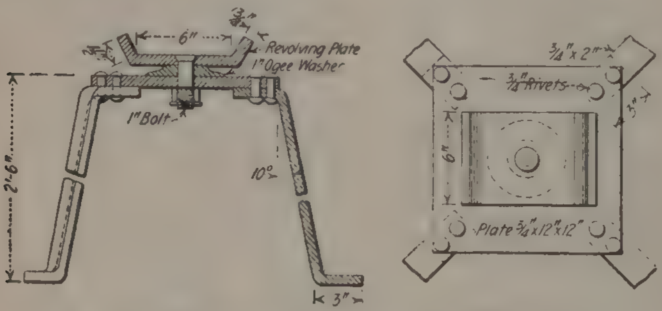
What can you do? You can make yourself an influence in your community. Your education entitled you to be a leader of thought among your fellows. Your training teaches you accuracy of mind and body and enables you to analyze propositions and deduce correct conclusions. Your place is in every public assembly, at your party caucus, and at your country's polls on election day. Establish and maintain local organizations, if only in your ward, to bring together the engineers for the purpose of discussing the questions of the day—not merely engineering questions, but every question which agitates or interests the citizenship—and when you have come to a conclusion to which you are ready to subscribe, go out and fight for it before the public, in your caucus and at the polls, and let the people know that you are one of two hundred thousand of the best-trained, most capable citizens of the republic, who is doing his duty by his fellow-men, by his profession and by himself.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Rails Economically Handled by Small Turntable

THE turntable shown in the accompanying sketch, reproduced from Engineering News-Record, is proving a big labor and time saver in handling rails for the new car-repair yard of the Pennsylvania R.R. now under construction at Greenville, New Jersey.



Small inexpensive turntable saves time in handling old rails.

The 85-lb. rails used are second-hand, and the ball of each is badly worn on one side. Since it is therefore necessary to place the unworn side on the inside of the track being laid, it happens that many of the rails have to be turned end for end before placing them. Previous to building the turntable it required considerable manoeuvering by a gang of at least six men to turn one rail. With the turntable, however, which is set about 18 feet from the track being laid, two men can turn a rail with ease. The device was made complete for $8.

An Economical Kink for Jetting Piles

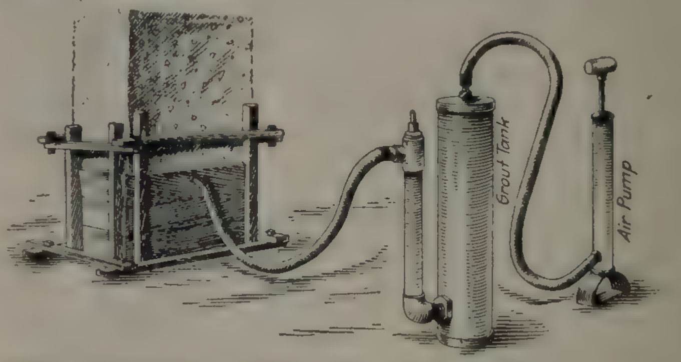
RECENTLY on a job where a large number of piles were to be driven, the superintendent of construction hit upon a scheme to reduce the amount of water used, and still obtain satisfactory results. It is described by H. B. McDermid, in Engineering & Contracting. By experiment he determined the right size pipe necessary to produce the hole for the piles he was using. Then after finding he needed about a 3½-in. pipe, to produce the right sized hole, he had the blacksmith draw down one end of his pipe to a smooth nozzle, with about a 1-inch to 1¼-inch opening. This greatly reduced the amount of water flowing, but as the outside of the pipe remained the same, the same size hole was jetted, as would have been done had the pipe been left the same size throughout.

In practice, the pipe, with hose connection at top and nozzle at bottom, is hung vertically in the leads of the pile driver, the water turned on, and the pipe lowered till the nozzle has washed away enough earth to get a good hole started. It is then lowered into the hole, where the high velocity of the jet readily cuts away and washes out a hole, whose size is governed solely by the size of the supply pipe to which the nozzle is attached, as the water must flow out of the hole, on the outside of pipe, and so cuts a hole proportional to the area of the pipe used. Reducing this necessary pipe size to the small nozzle reduces the amount of water used, increases the velocity of the stream for an equal amount of water used, and incidentally reduces the amount of mud and water underfoot, for the crew to work in. Slowly raising the pipe up and allowing it to gently chug down, further each time, greatly increases the speed of the cutting.

Simple Apparatus Repairs Defective Columns

TOO dry a concrete, not puddled enough, was the cause of peeling and disintegration at the bottom of columns. These columns, 15 ft. high and 20 in. square, were reinforced with eight 1⅛-in. rods bound with spiral reinforcement. A satisfactory repair was made in the following manner, which is described by J. D. Evans, in Engineering News-Record.

The concrete was cut off level and a wood form placed around the bottom of the column—the top board leaning out so as to form a hopper—and a piece of ½-in. pipe was put in at the high point of the cut, extending from the centre of the column out through the form. A fine gravel concrete was put into the hopper, thoroughly rammed and allowed to set for about two weeks. The forms were removed, and the patched part was trimmed to conform with the rest of the column.



Voids in repaired portion of column filled with grout forced in by tire pump

The voids in the repaired portion of the column were then filled with pure cement grout forced in through the pipe by a compressed-air apparatus made from a piece of 3-in. water spout, the top being sealed and having a valve from an automobile tire set in the centre, as shown in the drawing. The bottom was sealed also. From near the base a smaller pipe extended to about the top of the tank. After the grout had been poured in, this was connected by an air-tight line to the pipe cast in the column. By the use of an automobile-tire pump, the grout was forced into the voids. After pumping for some little time, water could be seen seeping out on the sides of the columns, showing that the scheme was working out satisfactorily. Several buckets of grout were forced into a few columns and undoubtedly filled all voids due to the shrinkage of the concrete.

When to Dimension in Feet and Inches, and When in Inches Alone

IN a communication published in the May Journal of the Boston Society of Civil Engineers, Mr. Sturgis H. Thorndike, of Fay, Spofford & Thorndike, Consulting Engineers, Boston, Mass., calls attention to the difficulty of making a standard rule which will determine when dimensions should be stated in feet and inches and when in inches only. In the hope of bringing out further discussion, Mr. Thorndike offered the following suggestions:

For use in engineering structures, the so-called English system of measures provides two units of lengths —the inch and the foot. The suggestion is that these be regarded as serving two distinctly different functions. The first unit is adapted to stating the width and thickness of any material or member which is constant in cross-section, but may have any convenient length; that is, the inch is the convenient unit in which to state size as distinct from length or distance. For instance, we habitually use the term 30-in. Bethlehem girder beam, 42-in. steel plate, 16-in. brick wall, 30-in. vitrified clay pipe, 38 in. by 50 in. egg-shaped sewer, 36-in. cast-iron water pipe, 12 in. by 16 in. yellow pine stick, 28-in. stone coping, 16-in. reinforced concrete slab, etc. We seem naturally to use the inch alone in these cases until the dimension exceeds 5 or 10 feet. On the other hand, we do not speak of a 720-in. roadway. I therefore believe that—perhaps subconsciously—we are using the inch as distinct from the foot and its subdivisions as the convenient unit in which to state the size of most materials and members.

The convenient unit for length or distance seems to be almost always the foot. This unit may be divided decimally, but such division is outside the scope of this present discussion. If it is to be divided into inches, and especially if a number of lengths or distances may sooner or later need to be added together, the greatest convenience seems to be attained when the inch is regarded strictly as a subdivision of the foot, not as a different unit, and consequently when we state a length as 1 ft. 7 in. not as 19 in.

This recognition of the existence of two units, one adapted for one purpose and one for another, may clear up much of the confusion and solve most of the difficulties, including the dimensioning of plates. It sometimes results in stating the same dimension in two different ways on the same plan according to the purpose desired; for instance, the size of an I-beam may be 15 inches, but the distance from a plate on the bottom of it to a plate on the top of it will be 1 ft. 3 in. Whether this is an advantage or not is open to question; to me it seems an advantage as emphasizing the difference in use between the two units.

There will still remain a wide field for the exercise of discretion. The limit of size to be stated in inches seems to be a matter of judgment and convenience rather than rule. We speak of a 120-in. wheel base on an automobile, but of a 10-ft. sewer. There will also be differences of opinion on the distinction between size and distance; one engineer will mark his concrete columns 28 in. by 32 in. for convenience in figuring stresses; another will mark it by 2 ft. 4 in. by 2 ft. 8 in., classing it as a mass of concrete.

Steam Specialty Business Acquired

The business of H. L. Peiler & Company, steam specialties, and of the Canadian Griscom-Russell Company, have both been acquired by the Mason Regulator and Engineering Company, recently organized in Montreal. The president is Mr. Eldon Macleod, treasurer of the Mason Regulator Company, Boston, and the treasurer and general manager Mr. H. L. Peiler. Mr. E. J. Hatton, formerly of the Canadian Allis Chalmers Company, has charge of the manufacturing and erection branch, and Mr. E. T. Jeffery, late with the John McDougall Caledonian Iron Works, and Mr. H. E. Kirkham, will look after the sales, under the supervision of Mr. Peiler. The Toronto office is in charge of Mr. J. Collins, formerly manager of the Canadian Steam Boiler Equipment Company. The Montreal offices are at 380 St. James Street. The company intend to go very strongly after business. It is proposed to manufacture in this country Mason reducing valves and other pressure regulation appliances, in addition to "Bundy" steam traps and "Coppus" blowers, and the marine and steam specialties of the Canadian Griscom-Russell Company, which include the widely known Rielly heaters, evaporators and distillers.

Trade Publication

Clay Products for Building Construction—published by the Sewer Pipe Manufacturers' Association, describing the use of vitrified clay products for flue linings, chimney tops, wall copings and house drains.

Mainly Constructional

East and West—From Coast to Coast

Estimates of paving work urgently required have been submitted to the Quebec City Council by City Engineer Baillairge. The amount is $46,000.

There is a marked shortage of house accommodation in the city of Regina, Sask., at the present time, and as a result considerable building activity is reported.

The Canadian Pacific Railway will rebuild one hundred feet of their coal dock at Owen Sound, Ont., north of the old power house site this summer. This is an extension of work carried out on the same dock last summer.

Work on Toronto's fine new registry office has just recently been completed and the formal opening took place on June 12. The building was started in September, 1914, and the foundation stone was laid on April 14th, 1915. The cost of the land was approximately $262,629, and the building, including architect's fees and fixtures, cost $462,614.

A two-storey section of the Arlington Hotel, Welland, Ont., built of concrete blocks, collapsed recently while alterations were being made. The lower floor was being changed into a theatre and removal of the partitions is thought to have left the top storey with insufficient support. The building is a complete wreck, but no one was injured, though three persons were carried down in the ruins. Fortunately, the accident happened at noon, when the workmen were out of the building.

Work is proceeding rapidly on the erection of the new mausoleum at Mount Pleasant Cemetry, Toronto, for the Toronto General Burying Ground Trust. This building was designed by Mr. Frank Darling, and it is expected that it will be one of the finest of its kind on the continent. It will be 225 feet long by 125 feet wide, with a chapel 26 feet x 54 feet. The exterior will be of granite, and the interior of polished marble, the windows of cathedral glass set in metal, and the doors of bronze. The funeral chapel will be a large and handsome structure with walls and pillars of marble.

Hon. F. G. Macdiarmid, Minister of Public Works for Ontario, and Mr. W. A. McLean, Deputy Minister of Highways, recently made a tour of inspection covering 300 miles of the good roads system of the province. They met with expressions of approval from the county councils regarding the work of road improvement and the encouragement offered by the government, and the condition of most of the roads covered was ample proof of the benefits derived. Addressing a gathering of county councillors at Guelph, Mr. McDiarmid stated that while the present was not a time to engage in an aggressive policy of road construction, he was convinced that the province could not do better than to provide adequate authority and means for a comprehensive programme of road building and improvement immediately following the end of the war.

During a recent storm some trouble was experienced in Burlington, Ont., with the town's new sewer system. It is stated that the sewers had been taxed to capacity and that the two pumps of the disposal works were unable to handle the quantity of sewage and rain water combined. Engineer Chipman, who was consulted by the council, stated that the combined sanitary and storm sewer on Brant Street was responsible to a great extent for the large amount of water. He pointed out that Burlington was planned on the separate sewer system, and no provision had therefore been made to take care of any roof water. If the town wished to continue the combined sewer on Brant Street, he said he could construct an overflow at the foot of the street, so that when the capacity of the pumps was overtaxed the water would flow into the lake. Otherwise, the roof water would have to be taken care of in some other way. The council decided to leave the matter over till the next meeting.

Personals

Mr. W. M. Brewer has been elected chairman of the Western Branch of the Canadian Mining Institute.

Capt. F. M. Moody, a graduate of the Faculty of Applied Science and Engineering, Toronto, has been reported wounded.

Mr. W. H. Breithaupt, M. Can. Soc. C. E., has been elected chairman of the new town-planning commission at Kitchener, Ont.

Lieut. Wm. B. Pennock, of Ottawa, who was recently reported wounded, is a 1915 graduate of McGill University, in civil engineering, and some months ago received special mention.

Mr. H. H. Vaughan, M. Can. Soc. C. E., has been appointed general manager of the Dominion Bridge Company. Mr. Duggan, former general manager, becomes Chairman of the Board.

Flight-Lieut. O. J. Gagnier, a 1917 graduate of McGill University in civil engineering, has been reported wounded. He went overseas to join the Royal Naval Air Service last year, having taken his preliminary course at Long Branch, Ont.

Mr. T. E. Price, A.M.Can.Soc.C.E., formerly resident engineer on the Vancouver division of the C. P. R., has recently been granted a commission as lieutenant in the Railway Construction Corps.

Mr. J. W. Seens, B.Sc., C.E., formerly general manager of the Structural Steel Company, Limited, Montreal, has joined the engineering staff of the Canadian Bridge Company, Limited, of Walkerville, Ont.

Mr. Marcel C. J. Beullac, B.Sc., M. Can. Soc. C. E., who for over two years has been an officer with the French forces, has recently been invalided home and has rejoined the staff of the Dominion Bridge Company at Montreal.

Mr. Edward Holgate, who has been chief draughtsman with the Structural Steel Company of Montreal for the past seven years, has accepted a position as chief engineer with MacKinnon, Holmes & Company, Limited, of Sherbrooke, Que.

Mr. E. Cotton, a land surveyor of Victoria, B.C., has joined the Sixth Field Company, Canadian Engineers, at North Vancouver for overseas service. Mr. Cotton is a native of New Westminster and has had eleven years' experience in survey work.

Lieut.-Col. S. H. Osler, of Cobourg, Ont., has been decorated with the D.S.O. by the British War Office. He went overseas in command of a company in the 2nd Canadian Division, with the Royal Engineers, and was promoted on the field to the rank of lieutenant-colonel. Col. Osler attended the Royal Military College at Kingston and took a course in engineering at McGill University.

Messrs. Wilfrid Lacroix and Alfred Nosworthy have formed a partnership and will practice as architects with offices at 58 Palace Hill, Quebec City, under the firm name of Lacroix and Nosworthy. Mr. Lacroix is a graduate in architecture of Laval University, Montreal, and is professor of mathematics and drawing at the technical school in Quebec. Mr. Nosworthy is from the Massachusetts Institute of Technology, and was formerly assistant architect with the Grand Trunk Railway System at Montreal.

Obituary

Mr. Josiah Mitchell, of Peterboro, Ont., agent of the De Laval Company, died recently at the age of 73, as a result of heart failure. Mr. Mitchell was much esteemed in the city and district.

The death occurred recently of Mr. H. F. Wilmot, of Toronto, after an illness lasting four years. The late Mr. Wilmot was born in Kingston and he came to Toronto ten years ago, and had been engaged in business as a contractor.

Lieut. Nelson C. Kenny, who previous to his enlistment had practised in the city of New Westminster, B.C., as a civil engineer, is reported killed in action. Lieut. Kenny joined a Victoria battalion about two years ago. He was born in Orillia, Ont.

Mr. James Warren, civil engineer and land surveyor, passed away at Walkerton, Ont., recently, after a brief illness. He was born in the County of Halton, Ont., near Acton, 80 years ago, and for many years was engineer for the counties of Halton and Bruce. In 1870, under contract with the Dominion Government, he subdivided into townships a section of the province of Manitoba, and subsequently did similar work in Saskatchewan and Alberta. In 1910, he carried out his last contract, which was for the subdivision of a section of Alberta lying among the foothills of the Rockies.

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Principal Contents

Page
Editorial 551
Straight Bar Slab Reinforcement Without Bands Used on 12-storey Eaton Factory 553
Financial Aspects of Road Paving Work 555
Overcoming Difficulties in Filtration 559
Practical Hints for the Contractor 561
Drifting Sand Filters in Oshawa 562
Plant of the Laurentide Power Company 563
Conservation and Increase of Our Domestic and Overseas Trade is Urged 567
Mainly Constructional 569

Construction Accidents

FIFTY per cent. of the accidents occurring on works of construction are preventable. This is a significant statement, made in an article published in the last issue of the Contract Record. It is significant because it gives an indication of just what remains to be done in the matter of promoting safety and precautionary measures. An accident is an expensive proposition, to look at it from a purely mercenary viewpoint. The prevention of accidents is, therefore, worth while from a dollar-and-cents standpoint. If one-half of the accidents are preventable, there is possible in their prevention a very considerable monetary saving. Every accident prevented is added profit, and it is, therefore, to the best interests of employers that they take such precautionary steps as will secure the greatest measure of safety.

The writer of the article referred to claims that practically no safety precautions have been enforced on construction work. This is in direct contrast to other lines of activity. In industrial work the prevention of mishaps is given a very considerable degree of attention. The railroads, too, have spent and are spending large sums annually towards educating their employees and the public at large into the ways of avoiding accidents. Hitherto, however, construction accidents have not been accorded the attention that their number and seriousness claim. To quote from our article, several reasons explain the difficulty met with in inducing contractors to safeguard construction work:

"First, the keen competition in bidding causes contractors to disregard calculations for safety in order to offer the lowest bid. Such employers object to the expenditure of any money for safeguarding, on the ground that they did not figure on it in their bids.

"Second, the constant changes in the nature of the work as construction progresses make each stage so temporary that the contractor is tempted to evade safety provisions, such as bracing and shoring excavations and providing rigid scaffolds, falsework, etc. He argues that it does not pay for such a short time.

"Third, the speed and high pressure under which most construction work is carried on cause the contractor to avoid anything which seems to him to retard the progress of the work.

"Fourth, the workmen themselves are often averse to bothering with safeguards. In their impatience to get ahead they will often use weak material because it happens to be nearest at hand."

* * *

A dollar-and-cents consideration of the value of safety measures ought to show contractors that the installation of such precautions pays by preventing costly accidents. The pressure of competition does not reasonably release them from using safety means. The two illustrations quoted by Mr. Rosenthal suffice to show this. On a $350,000 job the total cost of safeguarding workingmen was slightly over $1,000. This expenditure, comparatively small, prevented the accidents of fatal or permanently injurious consequences. Had such an accident occurred the loss to the contractor by way of compensation would have amounted to $3,000 to $5,000 per accident. Prevention surely paid. Another $250,000 project required a $12,000 expenditure for the prevention of accidents. With 3,500 men, nothing more than slight injuries resulted. The spending of $12,000 was not wasted. The risk was too great not to have some insurance.

We believe all classes of construction work, especially buildings or bridges, generally involve conditions that, under careless or incompetent management, may lead to danger and disaster. On the other hand, however, such work can be planned and arranged so thoroughly and accurately that it can be safely conducted when handled with proper care and with suitable equipment. Most accidents are almost always directly attributable to incompetence, recklessness, or disobedience in the case of employees. Careful direction of the work would largely prevent these. This is one of the first principles of safety in construction work—constant, competent supervision. This must be combined with frequent inspection of all construction equipment, such as derricks, hoists, scaffolds, ropes, etc.

If equipment is properly designed and carefully inspected much will be done toward reducing the 50 per cent. of preventable accidents. We read every now and then of derrick failures or scaffold breakages. Except in very rare instances, such mishaps and the consequent human loss are inexcusable. Eternal vigilance in such cases is the price of safety. The majority of injuries on buildings under construction are of this nature—breakages of apparatus or lack of guarding openings. Only stringently applied laws will help to overcome the accidents due to the latter. Our building by-laws are fairly comprehensive as to this point, but it needs strict compliance to make them effective.

Widely adopted compensation legislation is doing a great deal towards compelling contractors to prevent accidents. The propaganda of safety leagues and industrial bodies is helping in no less degree. Outside of all external agencies, however, contractors are realizing that it pays. They are looking at it from the point of view of profit and loss. They are seeing that every accident prevented is an item on the profit side; and it is this aspect of the matter that will do more than almost anything else to secure immunity from accidents.

Natural Resources Survey Now Under Government Auspices

THE recent appointment by Sir George Foster, Minister of Trade and Commerce, of the Honorary Advisory Council for Scientific and Industrial Research has provided an appropriate and exceptionally well equipped governmental agency to take over and expand the Natural Resources Survey initiated over a year ago by Lord Shaughnessy and organized by Arthur D. Little, Ltd., of Montreal, as its directors, with the support of the Canadian Pacific Railway.

The survey was undertaken by the railway because no other agency was then engaged in a work which was immediately recognized as an essential and fundamental requisite for the larger industrial development of Canada. It was at the same time obvious that the work itself was one which might with better reason and to greater advantage be carried forward by the government. The progress of the survey has fully justified Lord Shaughnessy's patriotic purpose, and has already demonstrated its usefulness in many ways. Tht obvious relation of the work to the published plans of the Honorary Advisory Council and the possibility of co-ordinating through the council the work of the survey with that of the various government departments led Lord Shaughnessy to approve the suggestion of Arthur D. Little, Ltd., that the survev be transferred to the official authority and direction of the council as a governmental agency. The proposal having been accepted by Sir George E. Foster and the council, the survey will hereafter go forward under government auspices, and the immediate direction of the Advisory Research Council.

Arthur D. Little, Ltd., will continue its intensive studies of specific industrial opportunities in Canada with largely increased capital and broader facilities for the establishment and direction of industrial enterprise.

Messrs. R. S. & W. S. Lea, Montreal, have prepared plans for a mechanical gravity filter plant for Pointe Claire, P.Q. The capacity of the plant is 900,000 imperial gallons per day, with a 3 h. 20 m. coagulation period. At present the town water, taken from Lake St. Louis, is treated by means of a chlorinator. The new equipment includes a low lift pump.

Work of the British Engineering Standards Committee

THE Yorkshire Post of May 15, 1917, contained an account of the work of the Engineering Standards Committee formed in 1901 by the co-operation of five leading engineering institutions for the purpose of "framing systematic standards to replace the increasing confusion in engineering manufactures due to engineers who designed the work and manufacturers who executed it being without general guidance as to the really available form and composition of the manufactured articles or their component parts." The original committee, consisting of only seven members, has now grown to an organization with a main committee of twenty-two members, with sixty-four sectional committees and subcommittees, as well as numerous panels dealing with standards relating to practically the whole of engineering practice. There are now over 500 members of the various committees. All are in important positions, and they freely give their time and experience, often at great personal inconvenience and expense. The first publication, the "Lists of British Standard Sections," was issued in 1903, and further specifications to the number of 77 have been added up to the present year, while several others are under consideration. Revisions of publications in order to follow advances in the subjects dealt with have been undertaken from time to time.

One important element in the success that the committee has achieved lies in the fact that the utmost care is taken at the outset to insure that all those who have, or could possibly have, any interest in the proposed work of standardization, through their leaders or recognized technical society or trade association, shall be adequately represented. In this way all parties have a consultative voice in the proposals, and the possibility of overlapping and subsequent friction is avoided. "The total expenditure of the committee since its formation in 1901 to March 31, 1916, has been approximately $248,192, an average of about $16,546 per annum. . . . Of this total $97,330 has been provided by the engineering profession in the form of direct contributions, $50,597 by the Treasury and $8,760 by the Indian Government. It would hardly be possible to find any other department of concerted action that has cost so little while saving so much."

Discussing Civic Tenders

The Montreal Builders' Exchange have been in communication with the Canadian Society of Civil Engineers and the Province of Quebec Association of Architects on the subjects of civic tenders being opened in the presence of the parties tendering and of the expediency of separating the heating and plumbing contracts from those of general contracts. The Builders' Exchange have asked for the co-operation of the other bodies, and Messrs. W. J. Francis, A. Surveyor and M. C. Beullac have been appointed by the Canadian Society of Civil Engineers to look into the questions. The Association of Architects will also meet representatives of the Exchange to discuss the matters.

Degrees in civil engineering have been conferred by the Faculty of Applied Science of McGill University on Walter George Hunt, Bury, Que.; Venance Lemay, Wyo., U.S.A., and Emmett Henry Smith, Ottawa.

Straight-Bar Reinforcement Without Bends Used on 12-Storey Eaton Building

Four-Way Flat Slab Construction Makes Use of Short Rods and Separate Mats Over Column Heads — Reinforcement Arrangement Described

IN a number of reinforced concrete flat-slab buildings being erected a rather new type of floor is being employed, distinguished by a reinforcement of short, straight bars, without bends. To provide for the negative moments at column heads, separate mats of unbent rods, placed near the top of the slab, are used, instead of the usual bent steel. The main slab steel is thus in short lengths from column to column, obviating the need of long bars. One of the flat slab buildings in which the straight-bar system of reinforcement is being used is the factory for the T. Eaton Company, on Alice Street, Toronto, of which a description of the construction plant appeared in the Contract Record of June 13. The reinforcement details of this building are outlined in this article, and will serve to indicate the general principles adopted in straight-bar work and the advantages applying to this system.

The reinforcing arrangement herein described applies to the typical floor, which is a 7½-in. flat slab. The average panel measures 20 ft. square. The columns are circular and provided with capitals and drop-heads 5 in. deep and 8 ft. square. The columns of the first eight storeys are steel-cored with heavy Bethlehem shapes. The upper four storeys have reinforced concrete columns without cores. The presence of the cores does not impose any material readjustment of the slab reinforcement. Slabs which are designed for extra heavy loading do not differ in the essential layout of the reinforcement from the arrangement outlined below for the typical floor. The only departure from the standard practice in this case is in regard to the number and spacing of the bars.

Separate Mat at Column Heads

The general bar lay-out consists of diagonal and rectangular bands in the lower part of the slab to take the main slab stresses. These bars extend from column to column without protruding beyond the limits of one panel. For the reinforcement of the slab against the negative moment over the column a separate mat or cross frame of bars is located over the column head near the top of the slab. This mat comprises straight bars in two directions, and has no connection with the bottom slab steel. The top mat is supported on small concrete blocks, which provide rigid supports for maintaining the mat steel in proper position and at the right level. The lower steel is held on steel chairs. The bars in both the bottom and top of the slab overlap sufficiently on each side at the line of inflection, as established by uniform loading, to provide a zone for the travel of the line of inflection which is reinforced at both top and bottom of the slab.

This general scheme thus secures four-way reinforcement for the main panel and two-way reinforcement for the column head. All bending of bars is eliminated, and short bars, not exceeding, in this case, 21 ft. for diagonal bottom bars, are made possible. The placing of steel is greatly simplified, and the concrete blocks and steel chairs ensure the correct location of both the mat and main panel steel.

The diagrams herewith graphically show the layout of the steel for both exterior and interior panels. In the Eaton building all of the slab steel is composed of ½-in. square twisted rods. For the interior panels the rectangular bands comprise 13 bars 13 ft. long, spaced at 9 in. centres. Each band is supported on three 3/8-in. square twisted rods 10 ft. long, held by chairs 1 in. from the form work. These rods are at right angles to the band rods. A 1-in. concrete fireproofing is thus provided below the steel. The rods comprising the rectangular band are staggered so that alternate bars extend 6 in. over the column capital. The diagonal bands are composed of nine rods 21 ft. long, spaced at 10 in. centres. These are wired together and supported on chairs. The rods are staggered in the same way as those of the rectangular band, so as to bring alternate rods 6 in. beyond the column capital.

For exterior panels the rectangular bands have 15 bars, with 8½-in. spacing, while the diagonal bands have 10 bars, with a 9-in. spacing. The straight wall bands of exterior panels consist of seven bars, 15 ft. 9 in. long, spaced 8½ in. apart. The three support rods carrying the rectangular bands act both as spacing and support bars and to take the temperature and shrinkage stresses.

Arrangement of Separate Mat

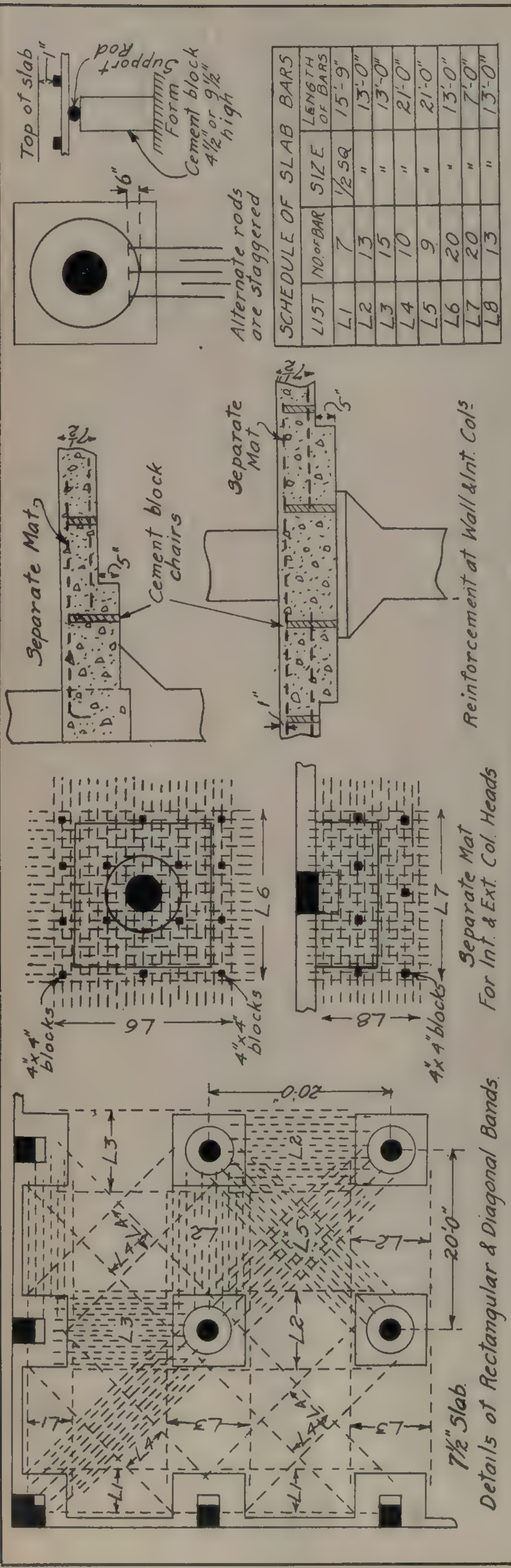
The mats which take the negative moment at the column heads have bars in two directions. There are twenty rods, 13 ft. long each way, tied together at 6 in. spaces. They are carried at the proper level by four support rods of ¾ in. round steel 10 ft. long, which rest on concrete blocks 4 x 4 in. in section. These blocks are 4½ in. or 9½ in. deep, according as they are placed in the main slab or in the drop head. The location of the mat is such as to give a 1 in. of concrete on top of the steel for fireproofing. This brings the top of the mat 6½ in. above the bottom of the slab and leaves about 5 in. between the mat and bottom steel.

Around the exterior columns, which are square and provided with brackets and drop-heads, a half mat is employed. The longitudinal rods number 13, and are 13 ft. long. The transverse rods, 20 in number, are 7 ft. long, and have 3 in. right-angle hooks to bond into the wall lintels. The rods are spaced at 6 in. In this case two support rods of ¾ in. round steel 10 ft. long are used, with cement block supports.

How the Steel Is Put in Place

The steel is laid as follows: First, the rectangular bands are placed by laying the spacing bars in their proper position on the slab form-work and then running the band bars, with their proper staggering and spacing, and wiring the whole together. The diagonal bars are then properly staggered and spaced and wired together into a rigid mat. The steel chairs which support both the rectangular and diagonal bands at the proper distance from the bottom of the slab are not placed till their pouring is about to proceed, so as to prevent injury to the reinforcement from rough usage.

In placing the mats the concrete support blocks are


Top of slab
1"
Support Rod
Form
Cement block 4½" or 9½" high
6"
Alternate rods are staggered
Separate Mat
Cement block chairs
5"
1"
Reinforcement at Wall & Int. Col's
L6
97
4"x4" blocks
L7
87
Separate Mat For Int. & Ext. Col. Heads
20'-0"
L1
L2
L3
L4
L5
L8
27
17
7½" Slab
Details of Rectangular & Diagonal Bands

SCHEDULE OF SLAB BARS

LIST	NO. of BAR	SIZE	LENGTH of BARS
L1	7	½ SQ	15'-9"
L2	13	"	13'-0"
L3	15	"	13'-0"
L4	10	"	21'-0"
L5	9	"	21'-0"
L6	20	"	13'-0"
L7	20	"	7'-0"
L8	13	"	13'-0"

Details of flat slab reinforcement featuring short bars without bends

first placed in position and the four support rods set on them. The bars comprising the mat are then placed at their required spacing and are wired together rigidly. Where columns have steel cores, as is the case in the first eight stories, the four centre bars of the mat in each direction are bent to pass around the core.

Short Rods Make Steel Easy to Place

A number of advantages of the system which has been outlined are evident. All long bars are eliminated. In this case, for 20 ft. square panels, the longest bar which occurs, a diagonal bottom bar is only 21 ft. long. Where bars do not exceed this length they are more readily obtained from stock and more easily handled. Owing to the separate mat arrangement there is no bending—an item that helps to reduce the cost of placing steel and makes it simpler to set in place. If desired, and it is advisable to do so on large jobs, the bands and mats can be assembled on the ground and hoisted to the building in units and placed by unskilled labor, ready for pouring. This would reduce the time of placing steel after the form-work is completed. The short lengths do away with the awkwardness of handling long bars, which require a large number of men to handle them, and possibly disturb inserts, pipe sleeves, etc., and interfere with workmen. The steel can be handled as fast as the carpenters can put up forms, since each panel is complete in itself. Moreover, the bars can be assembled and left on the decking until the floor is ready for pouring. Then the chairs and blocks can be set with the assurance that the location of the steel is correct. This prevents damage by workmen.

Column Reinforcing

The reinforced concrete columns of the Eaton building are reinforced with both longitudinal and spiral steel. Nine round rods, 1⅛ in. diameter and 17 ft. long, form the longitudinal reinforcing, and are tied to the spirals, which have a 2 in. spacing. The spirals and longitudinal rods are built up and erected in units and tied to dowels from the column of the storey below. In the cored columns there are four longitudinal rods, tied with ¼ in. round stock at 12 in. centres.

The beams and lintels have both trussed and straight rods, carried in stirrup frames. The stirrup frames have four 5/16 in. longitudinal rods, with 5/16 in. stirrups hooked for support on the form-work. The frames run the whole length of the beam or lintel, from column to column. The main rods are spaced and supported by saddles, fastened to the stirrups. Both the trussed and straight bars overlap 5 ft. beyond the columns.

The reinforced concrete stairs have ten ½ in. square twisted rods 14 ft. long, spaced at 6 in. centres, tied with 3/8 in. rods at 18 in. centres. The main rods fasten at their lower ends to 3 ft. dowels, extending from the floor or landing slab. In the upper end the rods are hooked, being provided with 6 in. 180-degree hooks. Where the stair abuts at its upper end into the landing a 5 ft. dowel, bent at the centre at 45 degrees, is placed.

Steel in Foundation Pedestals

The foundation piers of the Eaton building are 4 ft. square, spreading into mattresses 16 ft. square and 4 ft. deep. The spread mattresses are reinforced with four layers or mats of rods running in four directions. The lower two mats of rods, running longitudinally and transversely respectively, comprise six 1 in. rods 14 ft. long. The top two mats running diagonally have

1¼ in. rods, the four rods in one mat being 18 ft. and the eight rods of the other mat being 15 ft. 3 in. long. The method of constructing the foundation mattress is to pour about 9 in. of concrete, set one mat, pour another 9 in. of concrete, set the second mat, and so on.

On an average there were 85 tons of reinforcing steel to each floor, this including slab, column, stair, and beam and lintel reinforcing. The interior mats weigh 502 pounds, while the exterior mats weigh 316 pounds.

The Eaton building is being constructed by the Raymond Construction Company, and the reinforcing was placed under the direct supervision of Mr. J. Horne.

Financial Aspects of Road Paving Work

Author Considers the Essential Elements of Cost with the Object of Finding the Most Desirable Surface from the Standpoint of Economy

By Chas. A. Mullen[*]

THERE are two correlated viewpoints on which our road and street paving problems must be studied. First, we wish a serviceable and desirable pavement, maintained for our use not only upon a few of our roads and streets some of the time, but upon all of them all of the time. Second, we must secure the foregoing desired results at a cost that is well within our means of the present and our prospects of the immediate future. The first of these viewpoints was considered in the last issue of the Contract Record. Some of the essential financial considerations will be reviewed in this article.

The real paving question is how we can originally construct and permanently maintain at all times a serviceable and desirable pavement surface at a cost for originally constructing and permanently maintaining that will neither spell confiscation to the small abutting home-owner in his special assessment taxes nor bankruptcy to the general public fund in bond redemptions at interest and in current budget taxation.

The desirable features in a pavement from the viewpoint of economy are that it be originally constructed at a minimum cost; that its wearing surface be permanently maintained in a serviceable, sanitary, and desirable condition at a minimum cost; and that it be trafficked at a minimum cost for motive power and vehicular upkeep.

Under the heading of economy must also be considered very carefully the important items of home industry and the possible extent of municipal control and ownership of the production of the pavement. These two items, although they do not seem to have received great consideration, are of vital importance to those who must pay the pavement bills.

The Measure of Economy

The nearest we can get in a practical way to the true measure of paving economy is by carefully estimating the cost of original construction of the several kinds of pavement surfaces that are available or can be made available at a given locality, plus a sum of money that, when wisely invested, will provide an interest fund sufficient to maintain that type of pavement surface by repair and renewal, so that it may be looked upon as a permanent pavement surface, which matter of financial paving economy must then be considered in conjunction with the general suitability and desirability of the pavement surface for the purpose.

There is one factor that is not included in the above equation, but is scarcely a determining factor in many cases. That is the matter of the destruction of value incident to the removal of the pavement surface, or a part thereof, for the purpose of getting at the subsurface structures of a street, for street alterations and abandonments, or for any other purpose other than ordinary wear.

In all considerations of paving economy the factor of the interest on the money invested is a very important one not often given the serious consideration that its gravity demands. The municipal dollar is worth to its possessor about 4 cents, or 4 per cent. per annum; for that is about the rate of interest that municipal bonds of cities in good credit usually carry in normal times. It does not matter whether it is a dollar spent or a dollar saved, if it is a municipal dollar it is worth, or it costs, 4 cents a year; and it is often worth much more than that to the man who has it to pay or not to pay into the city treasury as the result of extravagance or economy in the carrying out of road and street paving improvements.

The Cost of Construction

In a consideration of the cost of the original road or street surface constructions the bituminous sheet layer surfaces have a very great advantage over the block surfaces. But before we can get very far into this subject it will be necessary for us to make some comparisons, and the author suggests the following:

Stone-filled sheet asphalt surface	$ .75
Standard sheet asphalt and binder surface	1.00
Vitrified paving brick or block surface	1.50
Creosoted wood paving block surface	2.25
Improved granite paving block surface	2.50

In each of the above cases the estimated price includes the laying in place of the entire wearing surface upon the concrete foundation, and the number of inches of grading made necessary by the particular displacement of the surface estimated, but the cost of such grading is but a very small item in any case unless there is rock excavation. The concrete foundations do not need to enter into our comparisons at all, they being almost always the same in all cases.

The thicknesses of the several wearing surfaces considered above are two inches for stone-filled sheet asphalt, three inches for standard sheet asphalt and binder, four inches for vitrified paving brick or block, three and one-half inches for the creosoted wood block, and five inches for the improved granite block surface.

When figures are made on the square yard unit basis, and the differences appear in cents, or at the most a dollar and some cents per square yard, all of us do not appreciate the gravity of these small differences. For that reason it will help to a better understanding of the subject if we work these unit figures into some interesting totals.

As an instance, take a municipality of but 50,000 inhabitants, which will probably have about 50 miles of streets, averaging 20,000 square yards of roadway surface per mile, or a total of about 1,000,000 square yards of street roadway that is, or ought to be, paved.

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[*] Director of Paving Department, the Milton Hersey Co., Montreal. Extracts from recently published book entitled "Paving Economy—Road and Street."

The table that follows will show the total cost of either originally surfacing or later resurfacing this entire area with a modern pavement surface of each of the several types under consideration as suitable:

Stone-filled sheet asphalt surface	$ 750,000
Standard sheet asphalt and binder surface .	1,000,000
Vitrified paving brick or block surface	1,500,000
Creosoted wood paving block surface	2,250,000
Improved granite paving block surface ...	2,500,000

It is at once seen that two square yards of stone-filled sheet asphalt wearing surface can be laid at the same cost as one square yard of vitrified paving brick or block surface, three square yards at the cost of one square yard of creosoted wood paving block surface, and three and one-third square yards at the cost of one square yard of improved granite block surface.

After a consideration of the above, it would seem to the author that there would need to be some very strong preponderance of physical and financial reasons to justify the laying of any other street pavement surface than stone-filled sheet asphalt; too steep a grade being the most common and important justification.

The Improvement Charge

The fixed annual interest charge per square yard on the original investment of our municipal dollars in the construction of pavement wearing surfaces is a matter of considerable importance, so let us see what it amounts to in the case of each type of pavement surface when calculated at the rate of 4 per cent.:

Stone-filled sheet asphalt surface	$ .03
Standard sheet asphalt and binder surface.....	.04
Vitrified paving brick or block surface	.06
Creosoted wood paving block surface	.09
Improved granite paving block surface	.10

To appreciate the gravity of these figures, one has but to multiply the given number of cents per square yard per annum of the interest charge on the cost of the original construction of each type of pavement surface by the one million square yards of street roadway area to be found in a city of but fifty thousand inhabitants, with this result:

Stone-filled sheet asphalt surface	$ 30,000
Standard sheet asphalt and binder surface ..	40,000
Vitrified paving brick or block surface	60,000
Creosoted wood paving block surface	90,000
Improved granite paving block surface	100,000

The above statements mean, for instance, that a city must be able to maintain permanently by repair and renewal a square yard of improved granite paving block surface for at least 7 cents per square yard less per annum than it can permanently maintain a stone-filled sheet asphalt surface before the two wearing surfaces will be equally economical; and in most cases, as will be seen later, this is impossible.

In other words, the improved granite paving block surface is laboring under a handicap of 7 cents per square yard per annum from the day of its laying because of its greater cost of original construction. It is only when we look into the full permanency cost, however, that the real gravity of the situation created by the interest charge becomes fully apparent.

The Cost of Repairs and Renewals

The material costs for making repairs due to wear will be about the same as in the case of the original construction of the several types of pavement surfaces. The labor costs will necessarily increase, because of the small quantities in which repair work must be done, but this increase will not be in any great disproportion for the several surfaces.

When repairs are made because of wear there is not much salvage to be had from the old surface materials, especially old blocks that lose their value with their shapes. What is left of the bituminous sheet layer surfaces is always perfectly good for reuse. What is left of old vitrified bricks and granite blocks is fit only for crushing into concrete material, unless the granite blocks are recut; and old creosoted wood blocks make a wonderful bonfire.

There is a time in the life of every pavement surface when it is more economical and desirable to take it up and completely resurface the foundation with a new wearing surface of the same or a different character; and though much that is said about the cost of repairs applies in proportion to the cost of renewals, there are still some points of difference worth noting.

The cost of the new surface when the original surface has worn out is practically the same as the cost of the original surface construction. The only material difference is that between the cost of the original grading for the displacement of the original surface and the cost of removing the old surface. The difference is not of sufficient moment to demand very much consideration.

No Salvage With Block Pavements

There is almost no salvage when a worn-out, old block wearing surface is torn up. With the exception of a small percentage of blocks that have been out of the line of traffic, the paving blocks are all so misshapen that they usually go to the crusher. The few good blocks can best be employed in repairing other streets of the same surface material, thus saving the purchase of new blocks. It is the author's belief that sheet asphalt pavements can be resurfaced for about 25 cents per square yard by putting the old surface through a plant operating on the street.

All the bituminous sheet layer surface material that remains on a street when it is found advisable to resurface it is salvage. The stone chips, sand and stone dust are no different than they were when originally laid, and the asphalt cement is the same except for the loss of some of the lighter oils that have been drawn out by the action of the sun and can readily be replaced by the addition of suitable flux.

Any way one looks at it, the economy of renewals lies with the bituminous sheet layer class of surfaces.

What Cleaning Costs

It stands to reason that the smooth, hard, and jointless bituminous sheet layer surfaces are the easiest and the least expensive to clean and keep clean. There should not be much difference between the cost of cleaning bituminous sheet layer surfaces and new paving block surfaces of the several types, but the difference grows as the surface ages. There is practically no increase in the cost of cleaning the bituminous sheet layer surfaces, as these remain smooth even in old age, but there is a very great difference with the block surfaces that roughen with age and acquire deep joints in which dirt will lodge and not readily leave.

In a report made by Messrs. H. deB. Parsons, Rudolf Hering, and Samuel Whinery regarding street cleaning in New York, these engineers remark that if their figures are even aproximately correct, they show that the kind of pavement surface in use in a city affects very materially the cost of keeping the streets clean; and they suggest that relative cost of cleaning is an element of no little importance in selecting the kind of pavement that a city should lay. It should also be considered that streets which can be cleaned cheaply are much more apt to be maintained in a sanitary condition.

The well-known authors of this report estimate the relative cost of cleaning the different surfaces we have under consideration as follows:

Sheet asphalt wearing surfaces	100
Vitrified paving brick surfaces	120
New wood paving block surfaces	105
Old wood paving block surfaces	125
Granite paving block surfaces	140

The difference between cleaning a sheet asphalt wearing surface and a granite block wearing surface, from other tables in the report, seems to be slightly over 1 cent per square yard per annum; not by any means an inconsiderable amount when multiplied by the one million square yards in our small city of fifty thousand inhabitants, to say nothing of the larger municipalities that house millions.

The Cost to Traffic

The ease of traction upon a given pavement surface with a given grade governs the cost of drawing or propelling a given load thereover at a given rate of speed. There are many minor factors entering into the equation, such as the use of too smooth a pavement on a very steep grade, and the slipperiness of certain surfaces under certain unfavorable weather conditions, but these minor factors are of special, rather than general, consideration.

The two chief factors are, of course, smoothness and hardness in the pavement surface, both of which qualities are possessed in a marked degree by all pavement surfaces now approved for use on modern city streets and heavily trafficked rural highways.

The bituminous sheet layer surfaces, because they are by a little the smoothest when new, and very much the smoothest as the different surfaces suffer from age and wear, are considerably less expensive to traffic upon all grades reasonable for their use than are any of the block class of pavement surfaces. The difference in cost increases as the roughness of the block surfaces becomes greater with age and wear, while the bituminous sheet layer surfaces, when kept in reasonable repair, remain smooth and become harder with age.

With the exception of the standard sheet asphalt mixture, all the bituminous sheet layer surfaces are sufficiently hard at all times, and in this special case the softness is only in evidence on very warm summer days. As an objection, this feature does not figure very heavily when averaged up for the year, and would not be a sufficient handicap to make this type of bituminous sheet layer surface second to any of the block class of surfaces in the cost to traffic when considered for the life of the various surfaces.

The Upkeep of Vehicles

There is not, as far as the writer knows, a particle of available data upon the cost of vehicular upkeep in its relation to pavement values, but an application of ordinary good judgment tells us that the smoother a pavement surface the less wear there will be to vehicles passing over it, and that the rougher the surface the greater will be the wear. The expense of maintaining vehicles in which to travel and transport freight in such cities as the Baltimore and the Brooklyn of a few generations ago must have been no inconsiderable item in the cost of living.

The matter of vehicular upkeep, though not reducible to figures by any convenient method of which the writer has knowledge, should still be carefully weighed before selecting a rougher pavement surface in preference to a smoother surface.

Home Industry Involved

The following table will show about how much of a city's money goes out of the community with the laying of a square yard of each type of pavement-wearing surface:

Stone-filled sheet asphalt surface	$ .25
Standard sheet asphalt and binder surface	.40
Vitrified paving brick or block surface	1.25
Creosoted wood paving block surface	2.00
Improved granite paving block surface	2.25

All of the above figures are high for many places, but they are in proportion.

It must be remembered that these figures hold good every time the pavement surface is repaired or renewed with new materials. The destination of money is a matter of legitimate enquiry when a community is spending it in large amounts, though by no means a governing factor. If one does not think so, he had best consult the president of his local bank on the subject and be properly informed.

Since the bituminous sheet layer surfaces are susceptible to indefinite resurfacings, using the old materials, with the addition of a little new material, not over 5 cents per square yard needs to be spent out of town each time the pavement is resurfaced.

Control of Production

Largely because of the greater amount of home industry involved in their manufacture, the possible outside control of the production of the bituminous sheet layer surfaces is less than in the case of any of the paving block surfaces.

A municipality cannot manufacture its own paving blocks at a great saving, for the reason that no one city can advantageously take the entire output of one block manufacturing plant of sufficient size for economical production. These plants are seldom in the city for which blocks are furnished, and shipments of blocks are frequently made from great distances by rail or water, and sometimes by both.

Most cities or progressive counties can use the entire output of one asphalt mixing plant that will produce any of the bituminous sheet layer surface mixtures, and some of the very large cities have several such plants operating to advantage within their corporate limits. A great many small places have such plants to take care of their repairs and renewals alone, and wherever they have been installed they have operated to advantage and at a reasonable cost.

The Permanency Cost

In order to find the present comparative cost of originally constructing and permanently maintaining a given type of pavement wearing surface upon a given road or street it is necessary to add to the cost of the original construction that sum of money that, properly invested, will produce in interest accumulations a fund from which may be taken such amounts as will be needed from time to time for repairing and renewing the pavement wearing surface under discussion indefinitely.

In the tables which follow, the writer has worked out the permanency cost of the pavements under consideration, using the comparative durabilities estimated by the author for heavy traffic conditions and residential light traffic conditions respectively. The permanency cost is the sum of the original cost, and an investment fund which represents an amount which, if invested, will produce in the time of durability the original cost as interest.

The first table shows the several permanency values, using the comparative durabilities estimated by the author for heavy traffic conditions; and the second table shows the values, using the durabilities estimated for residential light traffic conditions.

Table 1

Character of pavement surface.	Life. Years.	Original cost.	Invest'd fund.	Permanency cost
Stone-filled sheet asphalt ..	10	$ .75	$1.56	$2.31
Sheet asphalt and binder..	10	1.00	2.08	3.08
Vitrified paving bricks or blocks	5	1.50	6.92	8.42
Creosoted wood pav'g blocks	10	2.25	4.69	6.94
Improved granite paving blocks	25	2.50	1.50	4.00

Table 2

Character of pavement surface.	Life. Years.	Original cost.	Invest'd fund.	Permanency cost.
Stone-filled sheet asphalt ..	25	$ .75	$ .45	$1.20
Sheet asphalt and binder...	25	1.00	.60	1.60
Vitrified paving bricks or blocks	20	1.50	1.26	2.76
Creosoted wood pav'g blocks	25	2.25	1.35	3.60
Improved granite paving blocks	50	2.50	.41	2.91

Table 3

Character of pavement surface.	Permanency Cost.	Original Cost.	Invested Fund.	Life. Years.
Stone-filled sheet asphalt...	$4.21	$ .75	$3.46	5
Sheet asphalt and binder...	4.21	1.00	3.21	7
Vitrified paving bricks or blocks	4.21	1.50	2.71	11¼
Creosoted wood pav'g blocks	4.21	2.25	1.96	19½
Improved granite paving blocks	4.21	2.50	1.71	23

Table 4

Character of pavement surface.	Permanency Cost.	Original Cost.	Invested Fund.	Life. Years.
Stone-filled sheet asphalt ..	$2.31	$ .75	$1.56	10
Sheet asphalt and binder ...	2.31	1.00	1.31	14½
Vitrified paving bricks or blocks	2.31	1.50	.81	26¾
Creosoted wood pav'g blocks	2.31	2.25	.06	92¼
Improved granite paving blocks	2.31	2.50	.19	—

As it is quite certain that many will disagree with these estimates of durability, the third and fourth tables are compiled to show the number of years each type of pavement surface must endure to be even as economical as a stone-filled sheet asphalt wearing surface that endures five and ten years respectively.

What These Figures Show

Probably the most striking point in the foregoing tables of permanency values is found in the last section —Table 4—where it appears that on a given street, if a stone-filled sheet asphalt wearing surface will last ten years, an improved granite paving block wearing surface would be just 19 cents per square yard dearer, even if it lasted forever, without repairs or renewals. The stone-filled sheet asphalt wearing surface can be originally constructed and permanently maintained for that much per square yard of present value less than will be the actual cost of originally constructing the improved granite block surface.

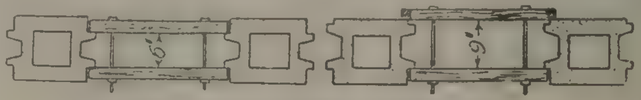
On the same street a creosoted wood block wearing surface must last 92¼ and a vitrified paving brick surface must last 26¾ years to be as economical as the stone-filled sheet asphalt wearing surface lasting ten years; and on a street where the latter surface will last but five years, the creosoted wood block surface must last 19½, the vitrified paving brick surface must last 11¼, and the improved granite paving block surface 23 years to be as economical. The block surfaces have no such comparative durabilities, not even the improved granite paving block surface.

It should be borne in mind while making these comparisons that, except for some special cases, the sheet asphalt surfaces are far more desirable physically than the block class of surfaces, and that they have other points of financial advantage, such as the lesser cost of cleaning, of motive power to traffic, of resulting vehicular upkeep, and the greater extent of home industry involved. Also, one should not overlook the lesser possibility of outside control when cities lay the bituminous sheet layer class of surfaces.

Another item that we have not considered above is the re-use of old wearing surface materials; and here we have already noted a very great advantage in favor of the sheet asphalt wearing surfaces.

Simple Concrete Construction for Dwellings Secures Low Cost and Rapid Erection

SIMPLE concrete construction suitable for dwelling houses and other buildings has been devised to secure a minimum cost of forms and rapidity of construction. It involves a combination of pre-moulded concrete sectional columns connected by sectional wall forms. The columns are made of comparatively short hollow blocks having pairs of shoulders projecting from their opposite ends. These are laid up rapidly in successive courses to the required height of the wall forms. They are keyed, clamped, or braced to correct line and the vertical interior space is filled with monolithic concrete containing the required vertical reinforcement rods. As soon as this concrete hardens, solid strong columns are provided and the panels of wall forms can be placed on each side between a pair of columns and drawn up tightly against the column by ordinary transverse tie bolts. After the form is concreted the lower portions of the panels can be removed and put on above in the usual way, thus providing rapid and simple construction for the walls.—Contracting.



Forms clamp to sectional column blocks.

Overcoming Difficulties in Filtration

Experience in the Management of Water Purification Plants is Related — Several Methods of Solving Practical Problems

IN a paper read at the recent convention of the American Waterworks Association, Mr. Lewis I. Birdsall, superintendent of water purification at Minneapolis, Minn., described some of the practical problems encountered by him during his experience in the management of mechanical filtration plants. The methods by which these difficulties were overcome are of general interest to designing engineers and superintendents of filtration, and are outlined herewith:

Keeping Coagulant Piping Open

One of the greatest problems lies in getting an ample supply of coagulant solution to the right place at the right time. When the writer assumed charge of the new Rock Island filter plant, in 1911, a 1½-in. lead-lined iron pipe carried the alum solution some 300 feet to the far end of the coagulating basin, the pipe being laid under the water of the basin. The available head for producing the flow of alum solution was approximately 4 feet. It was soon found that this line would not carry the required amount of solution because of clogging of the pipe by deposits from the alum and also because of entrained air. A hydraulic ejector was placed in the line, but, while it served to remove the air, it did not remove the deposits in the pipe.

More serious difficulties arose when the alum solution began to appear where least expected. Investigation showed leaks at the threaded joints where lead did not meet lead, and also at the bad spots in the piping where the lead lining was deficient. The line was mostly under water, so the difficulties were increased. Whole lengths of pipe were replaced, but the troubles continued.

The lead-lined pipe was replaced with a 2-in. composition conduit that was guaranteed to be unaffected by the alum solution. So it was; but when the water in the basin began to warm up in the spring, the conduit expanded and broke at the joints. Expansion joints of rubber hose were inserted, but when cold weather came the conduit contracted and pulled apart. Lead and brass pipe were then tried, but these clogged up with deposits of slimy material.

C. B. Henderson, manager of the Davenport Water Company, then suggested the use of four-ply rubber hose, which was installed in 50-foot lengths, and the troubles were eliminated. Whenever the hose clogged up it was removed, one length at a time, trod upon to loosen the deposits, and then flushed out with water under pressure.

It is only fair to state that recent information from Rock Island shows that fibre conduit is satisfactory when encased in concrete or other suitable material and not subjected to extreme changes in temperature.

Chemical-Solution Agitators

The agitating devices for the chemical-solution tanks were originally of the two-blade impeller type, driven by a 3-in. by 13-ft. hollow vertical shaft, direct-connected to a 1,720-r.p.m. motor of 2 h.p. The high speed of the impellers produced excellent agitation of the solutions, but caused the bending of the drift shafts and armature shafts in the motors. Corrosion of the steel shafting and bronze thrust bearing made much trouble and a high cost of maintenance.

It was decided to reduce the speed of the agitators to approximately 200 r.p.m. by means of reduction gears; to replace the 6-in. impeller blades with wooden blades 3 ft. long; and to make steady bearings at the centre of the vertical drive shafts. These changes eliminated some of the troubles, but there still remained the corrosion of the bronze bearings and the steel shafts. Also the agitators were very noisy, the motors having been set on a steel deck, supported by I-beams over the tanks.

The 4-in. hollow steel shafts were replaced with 4 x 4-in. oak shafts, the two blades made of one piece of oak and having an upward thrust at an angle of 45 degrees from the horizontal. One horizontal motor of 2 horse-power and 1,120 r.p.m. replaced the three vertical motors, and by means of shafting, clutches, and worm drive the speed of the impellers was reduced to approximately 10 r.p.m. The blades of the impellers were lengthened so as to reach within 6 inches of the sides of the tanks. The results have been very satisfactory. The noise has been eliminated, one motor does the work of three, there is no more trouble with the shafts or impellers, and the solution is amply agitated.

Automatic Chemical-Feed Controllers

Earl chemical-feed controllers were installed as a part of the equipment in the Minneapolis filtration plant, and they have proved to be of the greatest value in operation. Soon after they were put in service trouble developed with the electrical-control apparatus. The hydraulic valves on the supply line were controlled by pilot valves, and these, in turn, by electromagnets through ingeniously arranged contact points on the ends of the balanced arm at the top of each machine. The electromagnets would stick at times unless carefully watched; then the hydraulic valves would close off entirely, thus shutting off the entire supply of chemical solution, or the valves would open wide and the machines overflow.

One other trouble that developed was the continual chattering of the electrical apparatus and the constant movement up and down of the hydraulic valves, thus causing a continual fluctuation in the levels of the system. Also it was necessary to keep a small triplex pump running constantly to supply pressure for the hydraulic valves on those machines and a 10-volt direct-current motor-generator machine to supply current.

Balanced Float Valves and Hydraulic Control

It occurred to the writer early in 1913 that these difficulties might be eliminated by using balanced float valves and hydraulic control throughout. An experimental controller was made from soil pipe, and the plan was tried out with success. All of the electrical apparatus was then removed from the master and other controllers, and balanced float valves were installed. The master controller was equipped with two ¾-in. balanced float valves, one connected with the water-pressure line, so as to supply water to the right-hand tube of the master controller, and the other to a drain, so as to lower the water level in the same tube. The two balanced valves were then connected with a ¼-in. rod attached to the balance arm on the master controller in such a manner that, as one valve opens, the other closes. The relative adjustment of the two valves was secured by turnbuckles, and the balanced arm on top of the controller was weighted so as to compensate for the pull exerted on the opposite side of the fulcrum by the two valves.

Each of the three alum and two hypochlorite controllers was equipped with a 2-in. monel-metal balanced float valve, while 3-in. valves with iron body were used on the lime controllers. Each valve was connected directly with the balanced arm on top of the controller by means of ¼-in. rod and turnbuckle, as on the master controller. A glass sight tube was placed on each controller and on the master, with a graduated scale behind the tube. The result has been even more gratifying than was anticipated, and all troubles have been eliminated. The system automatically regulates itself with changing rates, and, aside from a slight adjustment occasionally of the turnbuckles or cleaning of the valves, no attention is required. Two triplex pumps, two motor-generator sets and complicated electrical apparatus have been eliminated, and there is no more fluctuation of levels in the system.

Liquid Chlorine

Hypochlorite of lime was formerly used at Minneapolis in conjunction with filtration. At first the hypochlorite was added to the water upstream from the filters, but it was found that tastes and odors appeared in the filtered water during the summer months. The hypo was then added to the filtered water, and fewer complaints resulted.

In November, 1915, because it was found impossible to secure a year's contract for hypochlorite, liquid-chlorine treatment was substituted for the hypochlorite. Three Wallace & Tiernan chlorine machines were installed, and, as a result, we would never again return to the use of hypochlorite if it were possible to avoid it. There have been no complaints of taste or odor arising from chlorine treatment since we began using liquid chlorine.

Sterilization of Distribution Mains

Sterilization by means of hypochlorite of lime of all distribution mains larger than 12 in. following their installation and previous to their being placed in service is now practised in Minneapolis with gratifying results. Experience has shown that flushing a pipe larger than 12 in. does not entirely remove polluting material which has entered the pipe previous to or during the laying of the same. If the pipe is large enough to permit, it is thoroughly brushed out, and then, as it is slowly filled, hypochlorite is added at the filling end in amounts large enough to leave a large excess of free chlorine, as shown by tests. Bacteriological analyses are made later to see that the water has been sterilized from one end of the pipe to the other. After allowing the pipe to stand full for several days, the water is completely drained out and the pipe flushed with fresh water if suitable drains are available. Otherwise, the pipe is flushed out through hydrants until tests show the water to be free from the chlorine added.

Painting Concrete

The inside surfaces of all concrete chemical-solution tanks are kept well covered with a good grade of asphalt or graphite paint. It was found that the alum solution was dissolving the limestone aggregate and otherwise decomposing the concrete walls of the tanks. Graphite paint seems to give better service than asphalt, the latter gradually dissolving off. A new paint, known as "Frost's Kapak Special Acid-Resisting Paint," appears to give as good results as does the graphite and is somewhat cheaper.

Strainer Plate Troubles

The mechanical filter at Minneapolis had not been in service sixty days before breaks occurred in the Tobin-bronze strainer plates. At first the breaks were scattered, but they became so frequent that it was necessary to remove all the centre strainer plates from all the filters. The brass-wire screen that had been bolted to the ridge blocks to hold the gravel down became such a nuisance at this time that it was taken out altogether, and the depth of gravel increased to 13 in., with a new size, 1½ to 2 in., added. The filters have washed better without the screen.

Tests of the tensile strength and bending of the Tobin bronze were made on strips cut from plates that had failed, but the tests seemed to show that the metal met the original specifications. Meanwhile the breaks continued, and it became difficult to keep enough filters in service to supply the city with water.

A decision was made to redesign the strainer-plate system, making the plates heavier, increasing the size of the holes in the plates from 1/16 to 3/32 in. and reinforcing the plates with bronze ribs. Enquiry was made of various users of naval bronze, and all agreed that the best grade of Tobin bronze should be adequate for the city's needs. The plates and bolts were then ordered made according to plans and specifications rigidly drawn by the designing engineer and approved by the city engineer, Mr. Cappelen.

The new plates and bolts were properly installed in one filter unit, and the filter was placed in service. Breaks occurred, and upon investigation it was found that the bolts in the centre had failed. A few of the plates also had cracked.

Carefully tested and inspected bolts and plates were replaced in the filter and the filter was put in service. Failures again occurred. Laboratory tests did not indicate any weakness in the metal or give any clue as to the cause of the failure.

The company which made the plates and bolts suggested that possibly the cold-working of the metal in making it into plates and bolts might have caused a rearrangement of the molecules. It suggested annealing the metal. The plates and bolts for one filter were heated in a furnace to a cherry red for one hour, removed, and slowly cooled. These were then placed in a filter and the filter put in service. The results were very gratifying, no breaks occurring. Since equipping the remaining filters with annealed plates and bolts only a few scattered failures have occurred. All trouble was confined to Tobin bronze, the Monel metal plates and bolts and those of medium brass having shown no failures.

Error in Description of Eaton Building

In the description of the twelve-storey reinforced concrete building for the T. Eaton Company, Toronto, published in our issue of June 13, on page 513, it was erroneously stated that the building contained 10,000 cubic yards of concrete. The correct yardage is practically 20,000.

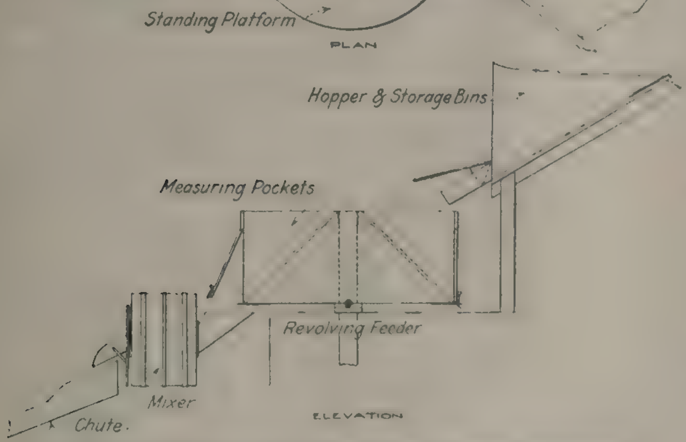
Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Revolving Feeder Saves Time in Loading Small Mixer Without Pivot Hopper

By James C. Foss, Jr.

THE accompanying drawing shows a method of feeding a small mixer which is not equipped with a pivot hopper, so as to eliminate time loss and still have an accurate measurement of the aggregate. The general rule is to feed a small mixer with wheelbarrows and measure the materials by calibrating the barrow, but the results by this method, including the personal equation of tired, hurried labor used in filling the wheelbarrows, are sometimes very far from the mix intended. By using the revolving wheel with the stone and sand pockets and trip latched doors the full quantities for a batch can be dumped simultaneously into the mixer; and, while this is being done, the opposite empty pockets can be filled. The cement is introduced by dumping from bags on top of rock bin as the rock goes out the door. With a 4½ cubic foot mixer an average of 50 cubic yards of concrete can be poured in a nine-hour day.—Engineering and Contracting.



A revolving feeder for a small mixer secures accurate measurement and saves time and labor.

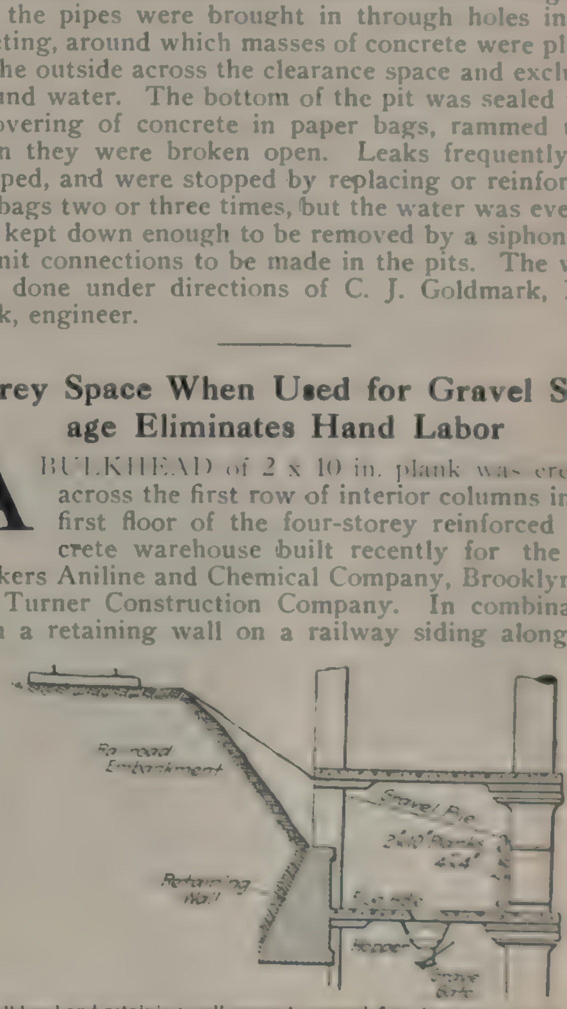
Clay and Concrete in Bags Keep Water Out of Trench When Laying Mains

THE reconstruction of the plant of the Canadian Locomotive Company, Ltd., at Kingston, Ont., involved laying several thousand feet of 10 in. cast iron pipe in trenches 2 ft. 4 ft. below water level. At the pipe joints the trenches were enlarged to permit men to work in them. The pits were sheeted with boards having openings on opposite sides for the ends of the pipes with the spaces around the pipes sealed with clay rammed in against the sheeting, and the bottoms of the pits were sealed by a covering of clay well rammed. The pits were sheeted with boards having openings on opposite sides from the ends of the pipes, with the spaces around the pipes sealed with clay rammed in against the sheeting, and the bottoms of the pits were sealed by a covering of clay well rammed. The pits were drained by a pump or siphon, which kept the water out until the hub and spigot joints could be poured and calked. No attempt was made to keep the water out of the trenches between these pits.

Special connections were made when pipes intersected or had valves or branches. Here pits 6 or 8 ft. square were excavated and sheeted down to subgrade, and the pipes were brought in through holes in the sheeting, around which masses of concrete were placed on the outside across the clearance space and excluded ground water. The bottom of the pit was sealed with a covering of concrete in paper bags, rammed until often they were broken open. Leaks frequently developed, and were stopped by replacing or reinforcing the bags two or three times, but the water was eventually kept down enough to be removed by a siphon and permit connections to be made in the pits. The work was done under directions of C. J. Goldmark, New York, engineer.

Storey Space When Used for Gravel Storage Eliminates Hand Labor

A BULKHEAD of 2 x 10 in. plank was erected across the first row of interior columns in the first floor of the four-storey reinforced concrete warehouse built recently for the W. Beckers Aniline and Chemical Company, Brooklyn, by the Turner Construction Company. In combination with a retaining wall on a railway siding along the building and with holes left in the floor for winter-weather heating, the bulkhead served to make a gravel storage bin of 300-yard capacity and to eliminate hand labor in loading the cars feeding the mixer. The ar-



Bulkhead and retaining wall converts ground floor bays into gravel bin.

rangement is plainly shown in the sketch, taken from Engineering News-Record.

There were four of the chutes shown, one under the flue hole in the centre of each of the four bays across the end of the building. The gravel, unloaded directly from cars into the bin, was drawn as wanted through these chutes by gravity into the cars.

Oshawa, Ont., Will Use Drifting Sand Filters in its New Purification Plant

THE town of Oshawa, Ont., in planning its new water filtration plant, has decided to adopt Ransome drifting sand filters of a type similar to those installed at the city of Toronto 60,000,000-gallons-per-day plant. The adoption of the drifting sand filters is an indication that the merits of this most modern filtration equipment are being recognized, and that the Toronto experiment, which is being watched very closely, will be repeated extensively in both large and small municipalities.

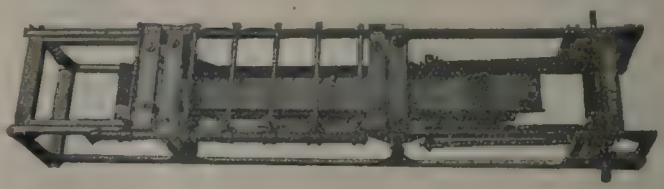
The contract for Oshawa's filtration plant has been awarded to the John ver Mehr Engineering Company, of Toronto. The plant which they will design and construct will have a capacity of 1,200 imperial gallons per minute, or 1,728,000 imperial gallons per day of 24 hours. The scheme consists of a filter house building of reinforced concrete construction, containing four filters, each 12 ft. square. The capacity of each filter is 300 imperial gallons per minute, and an overload capacity is stipulated to the extent of 20 per cent. over a 24 hour period. These filters are of the Ransome drifting sand type, the operating principles of which were described in the Contract Record of Sept. 6, 1916. The filter house building also provides for two sets of automatically-controlled, coagulating apparatus, two electrically-driven centrifugal pumps with a capacity of 650 imperial gallons per minute each, as well as the necessary heating and lighting arrangements. Provision is also made for storing 30 tons of sulphate of alumina. In connection with the filtration outfit a pure water storage reservoir of reinforced concrete, with a total capacity of 100,000 imperial gallons, will be built.

The plant is to be constructed directly to the south of the present pumping station supplying the town, and is situated within a short distance of the waterfront on Lake Ontario. The contract calls for its completion, ready for operation, by Dec. 31, 1917. The tender sum, as accepted, amounts to $34,060.

The scheme has been approved by the Provincial Board of Health of Ontario.

New Shaker Gravel Screen

The compact shaker sand-and-gravel screen, 18 ft. long, 3 ft. 2 in. wide and 3 ft. 8 in. high, shown on this page, has a daily capacity of 400 cubic yards. It is of steel construction, self-contained and readily portable, as it weighs but 3,600 pounds equipped with the spray washer. The top, of 2 in. mesh, takes the over size; the second is of ¾ in. mesh; the third mesh is 4 per inch, and is for roofing gravel; the fourth is 10 mesh, for torpedo sand; and the last, of 24 mesh, takes fine sand. The screens, which are made in 400 and 600-yard units by the Excavating and Screening Machinery Company, operate at approximately one-half cent per yard for power.



Road Work in Lincoln, Ont.

The Council of Lincoln County, Ont., has recommended an expenditure of $70,000 on the county's road system this year.

The illustration herewith shows the first girls in Canada to be employed in oxy-acetylene welding. These girls are on the staff of the Canadian Aeroplanes, Limited, which is controlled by the Imperial Munitions Board. The equipment used was supplied by the Carter Welding Company, Toronto. The instruction of the girls has also been undertaken in person by Mr. Carter, manager of this company.

Plant of the Laurentide Power Company

Turbine Capacity of 120,000 Horse Power—Transmission at 57,000 and 100,000 Volts—1800 Ft. Dam Forms Large Storage Lake

We illustrate herewith a number of the construction features of the Laurentide Power Company, Ltd. This company was organized by letters patent of the Dominion of Canada, with ample powers for the development of water power. The water rights include the ownership of the original Grand'Mere Falls, as well as the ownership of two falls located higher up the river, and rights for the location of dams, flooding of lands, etc. The water powers involved are all owned in fee simple by the Laurentide Power Company, Ltd

The site of the power plant is on the St. Maurice River, at Grand'Mere, P.Q., a point midway between Montreal and Quebec, and some thirty miles north of the St. Lawrence River. The St. Maurice River, one of the largest rivers in Eastern Canada, has a drainage area of 17,000 square miles. With the exception of the power development of the Shawinigan Water and Power Company at Shawinigan Falls, eight miles below Grand'Mere, the development described herein is the largest on the St. Maurice River.

A small development of 25,000 horse-power has existed at Grand'Mere for some thirty years, the whole power from this development being used by the company now known as the Laurentide Company, Ltd., formerly "Laurentide Paper Company, Ltd." On January 1, 1916, the Laurentide Power Company, Ltd., purchased from the Laurentide Company, Ltd., all the water rights, lands, machinery, etc. covering the water power and development at Grand'Mere, and in the St. Maurice River above Grand'Mere, appertaining to this development.

The development consists of a concrete gravity dam about 1,800 feet long, divided into sections. This dam is located along the crest of the Grand'Mere Falls. The control of the water-levels is obtained by the use of eighteen sluice gates, 40 feet in length by 18 feet in height, and operated by a moveable crane from the top of the dam. These gate-openings, with certain auxiliary openings in the power-house, etc., have sufficient area to permit of a maximum flow of 200,000 cubic feet per second, with a depth of water over the crest of the dam of 18 feet. The maximum height of the dam is about 60 feet. The dam, power-house, and all permanent structures are located on solid granite foundations.

Storage

The St. Maurice River at the present time has a minimum flow of about 8,000 cubic feet per second and a maximum of 175,000 cubic feet per second. When the storage works now being carried on at La Loutre are completed it is anticipated that the minimum flow will be increased to about 15,000 cubic feet per second. The available head at Grand'Mere at low water is 84 feet, and with this head the possible power development at Grand'Mere, taking into consideration the ordinary fluctuation of the load, is about 150,000 horse-power.

One of the outstanding features of the development at Grand'Mere is the large lake formed by the dam. This lake has an area of nearly ten square miles, and the back-water extends for a distance of some twenty miles above the power development at Grand'Mere; the large amount of water impounded by this lake will greatly facilitate the economical use of the water.

The power-house building consists of a steel frame, with brick walls, standing on a concrete substructure 450 feet long by 180 feet wide. It is completely equipped with all the machinery and apparatus for six water-wheel units, and partly completed for three additional units. For these three additional units provision has been made by leaving openings, providing the gates, etc., in the bulkhead wall, and building up the foundations to a point just below where the water wheels will be located. The building is provided with ample space for transformers, oil circuit breakers, high-tension and low-tension bus bars, etc. The gatehouse, located just above and in the rear of the power-house, and covered by the same building, is fully equipped with gates and rack-operating mechanism.

Turbines

Water-wheels and auxiliary machinery were manufactured and installed by the I. P. Morris Company. The turbines are of the vertical shaft, single runner type, installed in scroll casing and draft tube, moulded in the substructure. The turbines are rated at 20,000 horse-power each under a head of 78 feet, and operating at a speed of 120 revolutions per minute. These machines are controlled by automatic Lombard governors, provided with electrical devices for regulating the speed from switchboard.

Generators, Etc.

The six generators are vertical units of 16,400 kv.a. capacity, three-phase, operating at 6,600 volts, 60 cycles. Each generator is equipped with its own exciter machine. Below the exciter and above the rotor of the generator is a thrust bearing of the Kingsbury type, the whole load being carried on a film of oil. The electric current on leaving the generators passes through oil switches mounted on a gallery just behind the generators, and from that point to the low tension buses through to the transformer room, where are located three 9,000 kw. transformers, which change the voltage from 6,600 to 100,000 volts. At this voltage power is transmitted to Shawinigan Falls, where it is fed into the system of the Shawinigan Company. An additional bank of three 9,000 kw. transformers is now being installed. Another bank consisting of three 5,000 kw. transformers, changes the voltage from 6,600 to 57,000 volts, at which voltage it is transmitted to Quebec, Three Rivers, and other points.

The usual equipment of lightning arresters, automatic relays etc., is provided. In order to provide against failure of the direct connected exciters two motor-generator sets are installed, which can be used in case of necessity. The switchboard or control room is located at the top of the building, in the west end, where the control of the entire station is centralized. The six generators, with switching equipment and Tirrill regulator, circuit breakers (reactance type "C"), resistance coils, etc., were supplied by the Canadian Westinghouse Company.

The Illustrations

The illustrations herewith, which we reproduce through the kindness of the Laurentide Power Company, show the main features of the work. Fig. 1 is a general view of the plant, discharge side; Fig. 2 shows a cross-section plan of the power house; Fig. 3 shows a closer view of the intake side; Fig. 4, the dam and regulating gates at Grand'Mere; Fig. 5, generator room; and Fig. 6, the switchboard room.

On January 1, 1916, contracts were entered into with the Laurentide Company, Ltd., and the Shawinigan Water and Power Company for taking the entire output of the Laurentide Power Company. Under these contracts the purchasing

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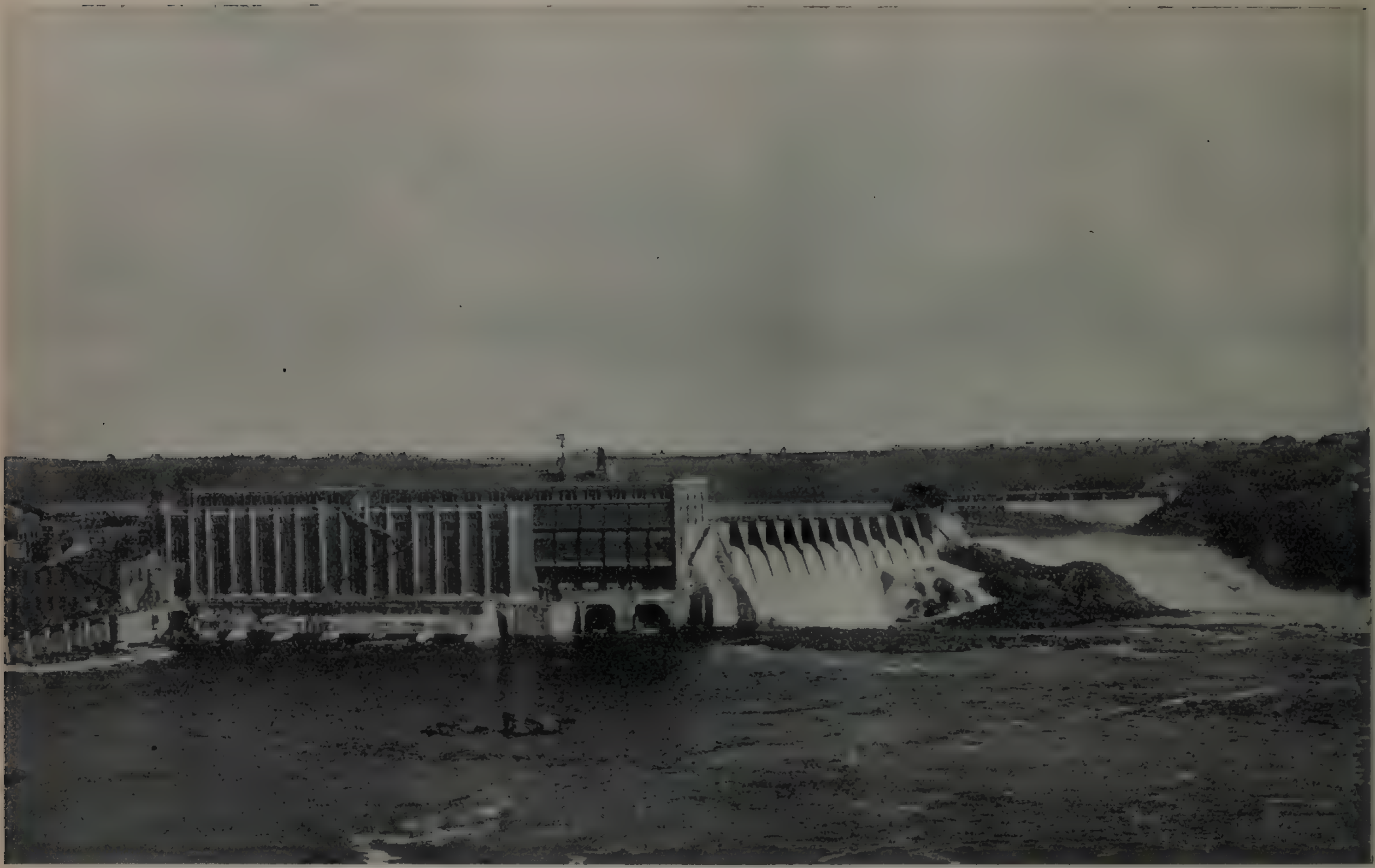

Fig. 1—Plant of Laurentide Power Company, Limited

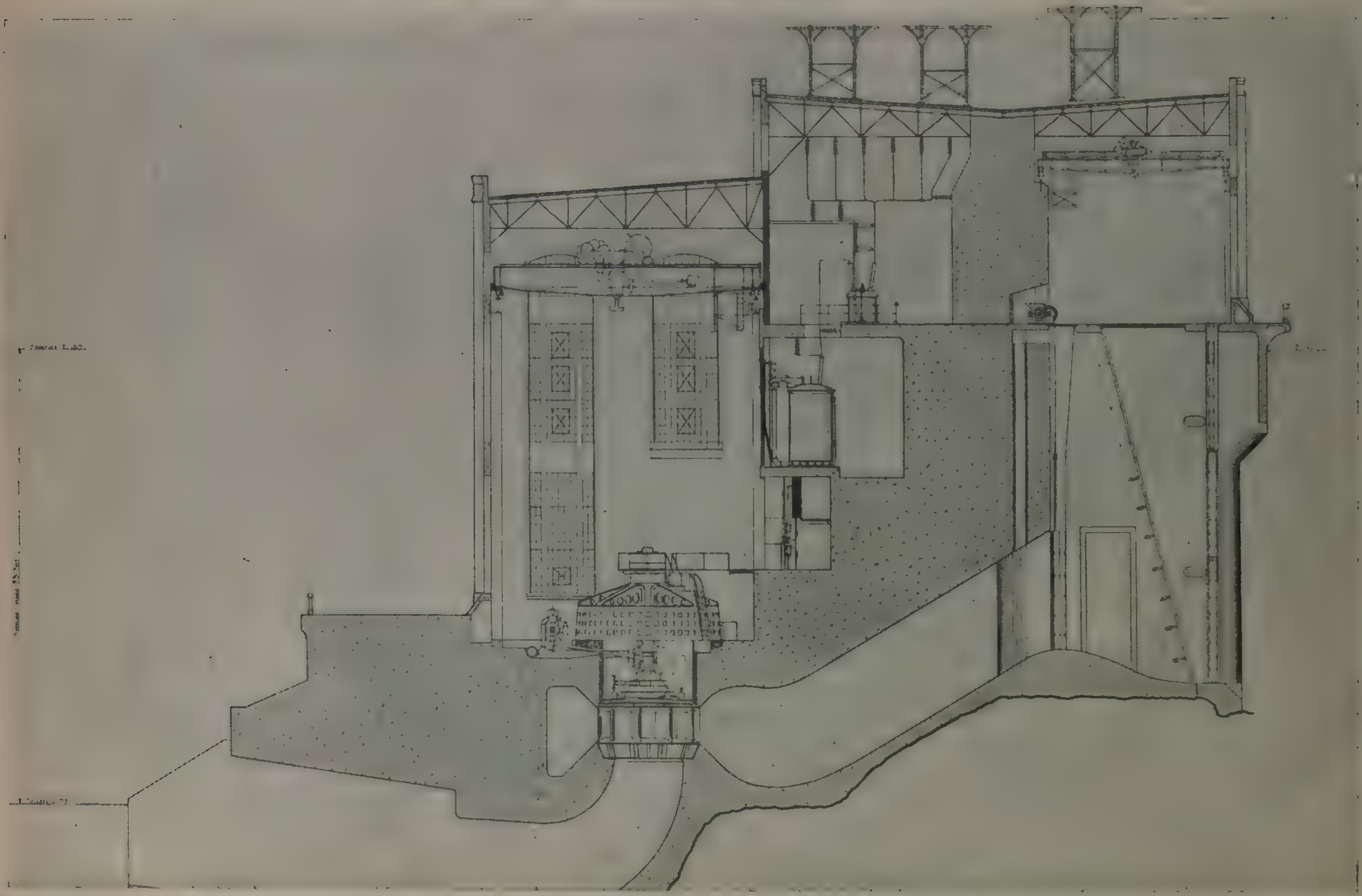

Fig. 2—Cross Section Plan of Power Station

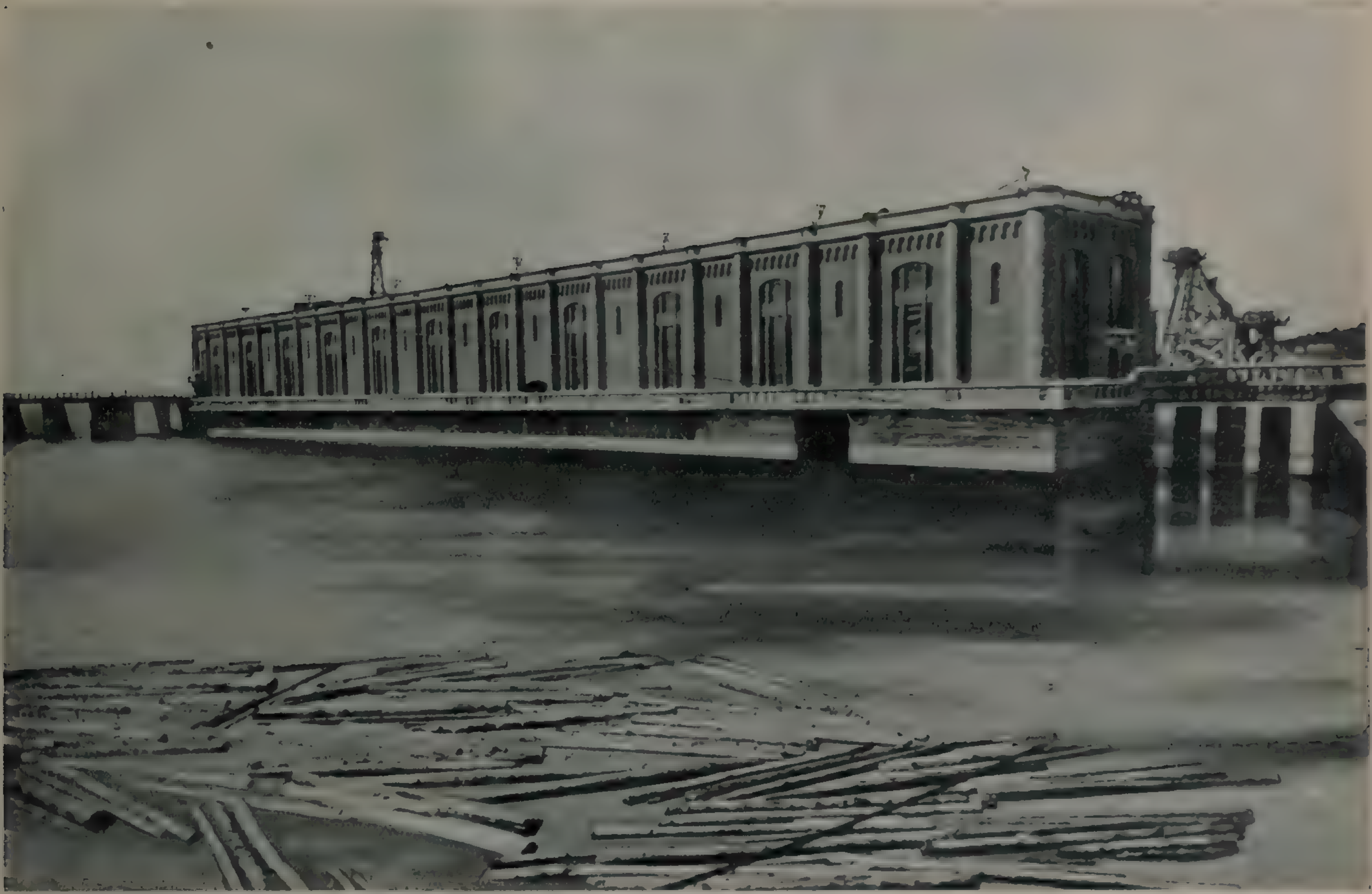

Fig. 3—Upstream View of Power House

Fig. 4—Regulating Gates on Dam, Grand'Mere

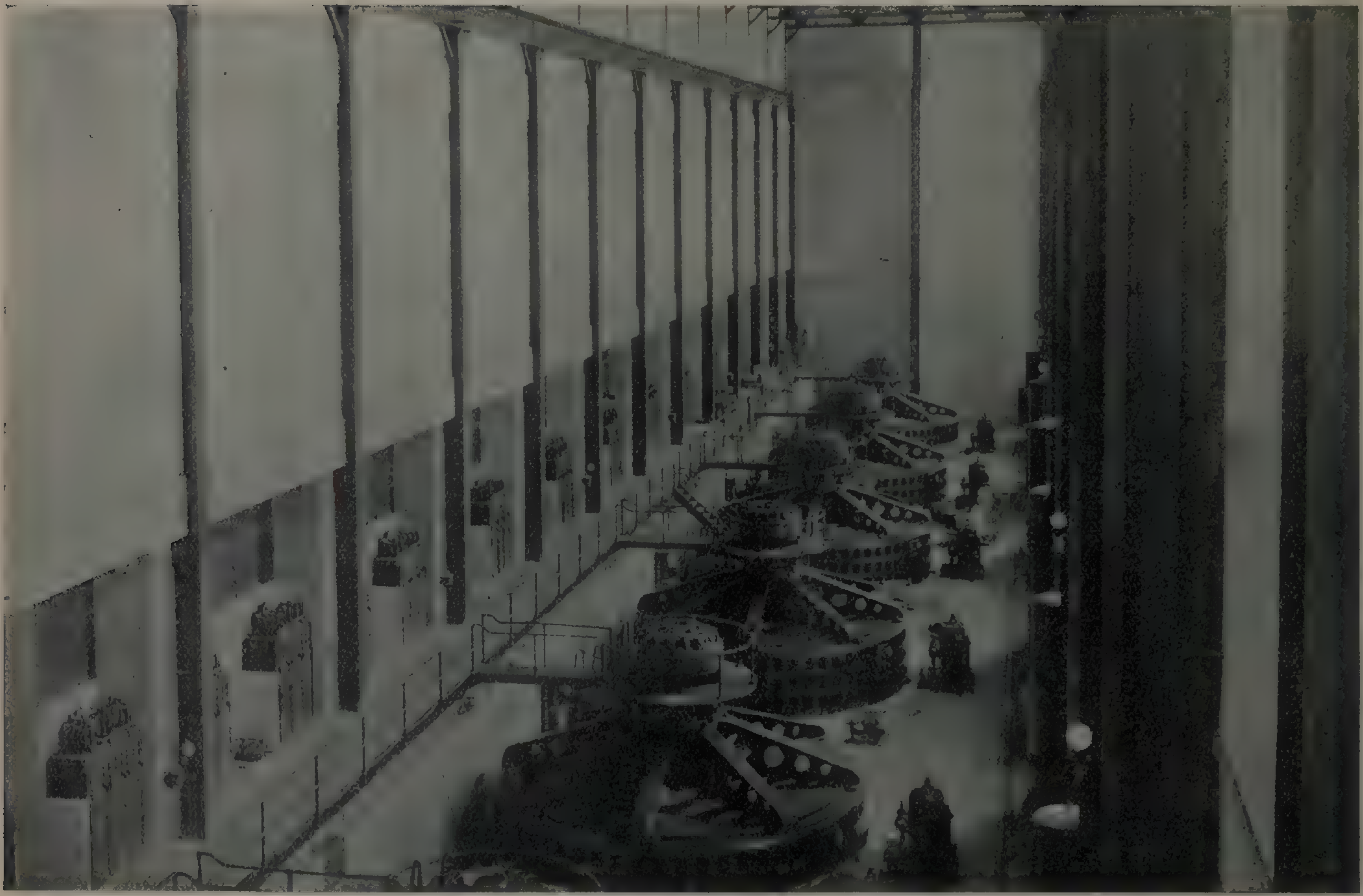

Fig. 5—Generating Room—Power House

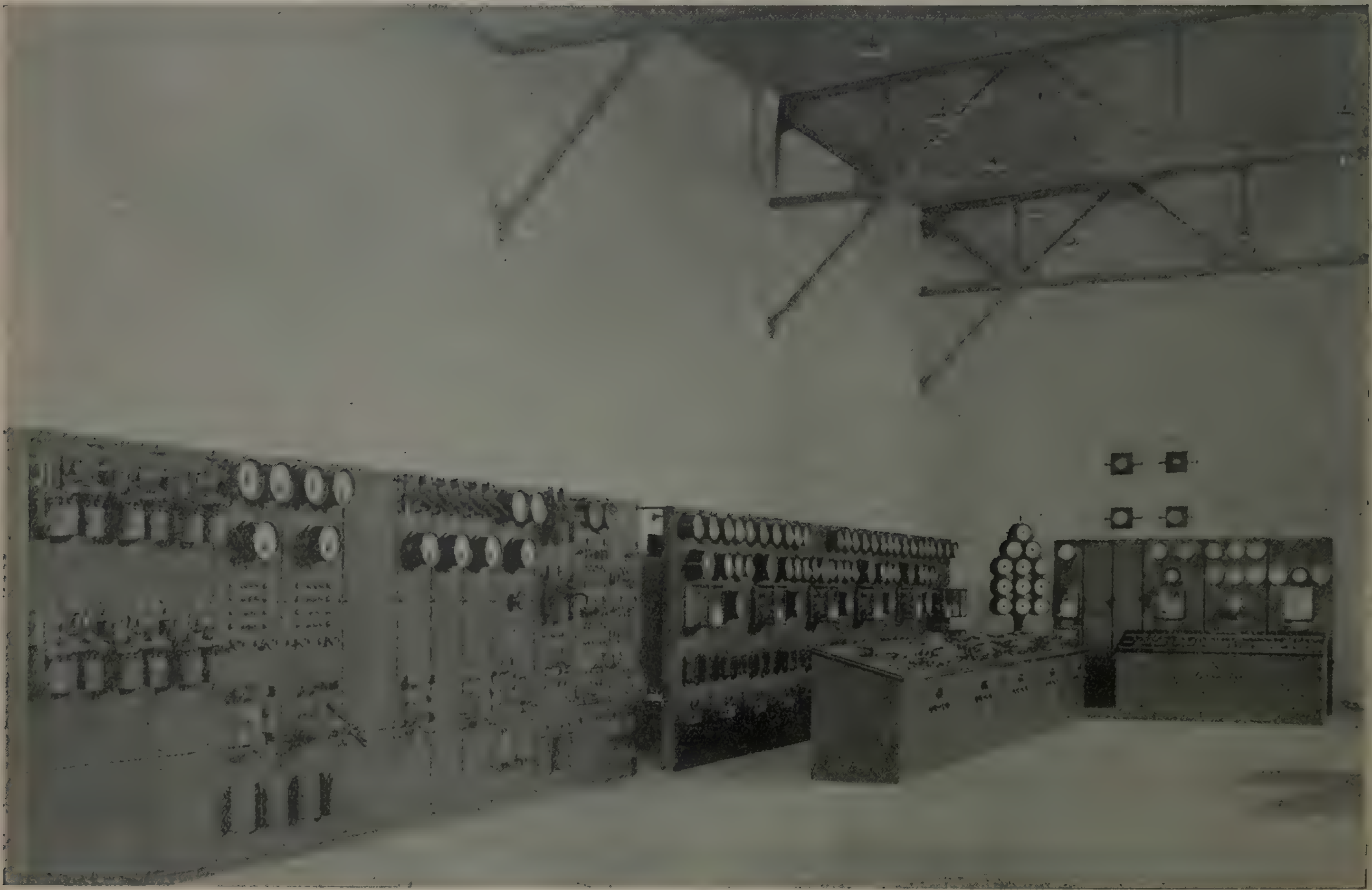

Fig. 6—Switchboard Control Room—Power House

Plant of the Laurentide Power Company

(Concluded from page 563)

companies take delivery of the power in the station of the power company, thereby relieving the power company of any expense in connection with the construction of transmission lines, etc. At the present time these contracts are in force to the extent of 25,000 horse-power delivered to the Laurentide Company, and 30,000 horse-power to the Shawinigan Company, a total of 55,000 horse-power. This amount will increase steadily so that by the middle of 1918 the Laurentide Power Company will be delivering at least 75,000 horse-power, and after that date it is expected the load will increase rapidly to the full amount of 125,000 horse-power.

The Laurentide Power Company has made an arrangement with the Shawinigan Water and Power Company by which the latter company undertakes the operation of the power plant, thereby giving to the Laurentide Power Company the wide experience of the Shawinigan company, as well as any necessary assistance from its engineering staff, which may be required in connection with the operation of the plant. The ownership of the Laurentide Power Company is vested largely in the Laurentide Company and the Shawinigan Water and Power Company.

The fundamental conditions for a successful hydro-electric development are clearly at hand at the plant of the Laurentide Power Company, i.e., moderate capital cost, an ample supply of water, a practically constant head, and a plant built on the most modern designs and founded on solid rock

Conservation and Increase of Our Domestic and Overseas Trade is Urged

Senator Frederic Nicholls, speaking to the debate on "Conservation of Canadian Trade," in the Senate on June 5, offered the following resolution:

> That in the opinion of this Honourable House, it is expedient to appoint a committee to inquire into and report upon the best method or methods of conserving and increasing our domestic and overseas trade to the end that our present prosperity may not unduly suffer when the stimulus resulting from orders for munitions and other war supplies is removed, and that the committee consist of Hon. Messrs. Beaubien, Edwards, McLennan, Dandurand, Gillmor and the mover.

Senator Nicholls said in part: "Presently this country is, notwithstanding the war, but rather as a result of the war, experiencing a period of great prosperity. Prior to the commencement of the war Canada borrowed about three hundred million dollars each year from Great Britain, partly to pay interest on debts already contracted, and partly to develop our resources and for industrial investments. When the tocsin of war first sounded this source of supply was shut off immediately. For a short period trade and finance were severely disorganized, but the recovery was not long delayed, and our recent trade returns—and figures in the final analysis are what count—almost surpass belief. Quoting from the recent Budget speech of the Honourable the Minister of Finance, I may point out that during the first year of the war the revenue from all sources was about $130,000,000; it rose during the second year to $170,000,000; but for the year ended the 31st March last the revenue increased to $232,000,000. Our total war outlay since the beginning of hostilities is over $600,000,000, and is constantly increasing, and this expenditure has been met partly from revenue and partly from the proceeds of domestic loans, which have aggregated $350,000,000; and in addition our chartered banks have loaned to the Imperial Treasury over $150,000,000 to meet its commitments for munitions and supplies purchased in Canada.

Large Munition Orders

"It should be remembered, however, that a very large proportion of our prosperity is the result of extraordinary orders for war materials and supplies, amounting to vast sums, some estimate of which may be realized when I cite the fact that orders received by the Imperial Munitions Board alone amount at this time, in round figures, to about one billion dollars, and that of this sum about six hundred million dollars has already been disbursed to manufacturers in payment for munitions, and that engaged in this manufacture, directly and indirectly, there are over 250,000 workers. Further vast sums have also been paid out in the purchase of grain and other farm products, machinery, clothing, woollens, and an infinite variety of Canadian natural and manufactured products. It is because of this that my resolution draws attention to the absolute necessity of some action being taken to minimize, if at all possible, the sad check this country will receive when this source of income fails us.

"After the war ceases there will certainly be a period of disorganization, when the balance of trade, which for some time past has flowed steadily in our favor, will commence to recede. The countries now at war, however, particularly those that have been devastated in Europe, will require to expend immense sums in reconstruction, and will become customers of those countries which are most ready to supply the requirements promptly and at a reasonable price. In this country we have had little experience in either looking for or catering to an export trade, and if we desire to share in the volume of business that will be offering overseas we can make our preparations none too soon.

"Admitting that Germany in the past has built up her vast foreign trade largely through the help of the State, and admitting, as intimated by Sir Robert Borden, that State aid will be extended at even greater lengths after the conclusion of the war, it behooves us to consider whether we in Canada will leave to the individual the development of the foreign trade that might naturally accrue to Canada, or whether the government of this country will, in some form, undertake to assist in the development.

"Alexander Behr, vice-president of the Russian Chamber of Commerce, Moscow, in an article in the Journal of the Russian American Chamber of Commerce, makes the claim that:

> Germany's great increase in foreign trade up to the time of the war was due, more than to any other factor, to: first, the co-operation between her business men and her government; and second, the foresight and liberal methods of her bankers. Her banking facilities were shaped to suit conditions abroad, and her bankers came into direct and close contact with the people whose trade was sought. Credit conditions were studied at close quarters, and business was done through the banks.

Banking System at Fault

"Next to intelligent assistance from the state it is obvious that in foreign trade the question of credit is the most important item, and in Canada our banking system does not tend to encourage the granting of credit for foreign exports other than on bills of exchange drawn against actual shipments, or commodities in elevators or warehouses. It is no criticism of the banks to draw attention to the fact that provision has not been made for a specific department for granting credits against exports of manufactured goods, for until now the necessity has not been urgent, and our manufacturers had not, prior to the war, developed to the extent that they were in a position to cater to the world's markets.

"Since the war, as I have pointed out, we have manufactured and shipped upwards of six hundred million dollars' worth of munitions alone, and I venture to say that the production of munitions is the most intricate, the most delicate, and the most precise class of manufacture that could be undertaken. It was an entirely new industry to Canada, and it is a credit to Canadian industry that in such a short time so many existing factories were reorganized and new ones established that have turned out such an immense quantity of munitions, and thereby brought to Canada so large a sum as six hundred million dollars for munitions alone. If the manufacturers, when the need arose, were able to accomplish such results I take it that they would be equally resourceful in manufacturing many other lines of goods for export that will be required by the European countries, we hope at no late date; but in order to bring this about some systematic method of state aid will have to be adopted.

Finance Committee Report

"That assistance in some form is necessary is not to be wondered at when we consider that even in Great Britain they have felt the necessity of grappling with the same problem. It has been admitted that the German national system of manufacturing for export, and system of banking facilities for export trade, were far in advance of those which obtained in Great Britain, and having these facts in view the British Government appointed a committee known as "The Committee on the Financial Facilities for Trade." A perusal of their report to the British Board of Trade is most illuminating. It is too voluminous to quote in extenso, but I bespeak your indulgence in quoting one or two of the salient clauses, one of which says:

> We recognize that the British manufacturers may be frequently in want of finance of a kind which a British joint stock bank with liabilities could not prudently provide, whereas the German banks in particular seem to be able to afford special assistance at the inception of undertakings of the most varied description, and to have laid themselves out for stimulating and promoting and to carrying them through to completion. We conclude therefore that there is ample room for an institution which, while not interfering unduly with the ordinary business done by British joint stock banks, by colonial banks, and by British foreign banks and banking houses, may be able to assist British interests in a manner that is not possible under existing conditions.

"The report further recommended that the main features of the Trade Bank should be as follows:

> It should not accept deposits at call or at notice.
>
> It should open only current accounts for parties who propose to make use of the overseas facilities which it would afford.
>
> It should have a foreign exchange department where special facilities might be afforded for dealing in bills in foreign currency.
>
> It should open a credit department for issuing of credits to parties at home and abroad.
>
> It should inaugurate an information bureau.
>
> Where desirable it should co-operate with the merchant or manufacturer, and possibly accept risks upon joint account.
>
> It should become a centre for syndicate operations, availing itself of the special knowledge which it will possess through its information bureau.
>
> It should receive government assistance.

British Government Favorably Impressed

"This report was not only seriously, but most favorably received by the Government, and, really at their suggestion, a British Export Bank, to be known as the British Trade Corporation, was promoted, and I have just received from Sir Albert Stanley, of the British Board of Trade, which is a department of the Government, a copy of the petition of the promoters, deed of settlement, and the royal charter of incorporation.

"Now, I think I have shown you that the great development of German trade abroad was brought about in a comparatively short time by an intelligent system of state aid, and by a system of banking specially developed for the promotion and extension of foreign trade. I have also shown that some of the keenest business men in England, members of a committee appointed by the British Government, have arrived at the conclusion that the only way for the British manufacturer to successfully compete after the war in foreign markets is to adopt a system somewhat similar to the German system, and their recommendations have been approved by the Government, and a royal charter granted to a British trade corporation, sympathetically in alliance with the Government, and with an initial capital of ten million pounds sterling.

"It is not my purpose to urge any definite line of policy, but I do urge that a committee of the House be appointed so that this important matter may be given serious consideration with the hope that after the evidence of those in this country best qualified to advise in this matter has been heard it may be possible to formulate some plan that may measurably attain a result so greatly to be desired.

A Trade Bureau

"It is a question whether it would be, or would not be, too radical a proposition for the Government to consider establishing a trade bureau, or a department, which would actually sell Canadian products in foreign markets and distribute the orders received amongst Canadian producers of natural and manufactured goods. Such a plan to my mind has much to recommend it. A government department as sales agent would carry more weight than an individual or corporate body could. It would also be able to finance trade credit on a much lower basis of interest, and thereby create a trade that it would be impossible for the individual to develop. The proof that such a plan is feasible is at hand. The Imperial Munitions Board is a department of the British Government and has practically sold to that Government hundreds of millions of dollars worth of munitions in bulk, and have distributed this vast volume of trade amongst hundreds of Canadian firms, thereby saving the country from a period of depression when normal trade was dormant, affording profitable employment to thousands of men and women, who otherwise might have been a charge on the community. For further proof the War Purchasing Commission, a department of the British Government, may be cited, where we have millions of dollars worth of Canadian products sold to allied nations, and the orders distributed broadcast to people who of their own initative would never have sold to a foreign market.

Constructive Statesmanship

"When the war ends we run great danger of a panic through disorganized trade conditions, unless the government lends a helping hand. Hundreds of millions of dollars have been spent in the construction of canals and the development of our waterways, and we are to be called upon to advance millions for the construction of good roads, but of what advantage are these public works unless an expanding trade calls for their utilization. A few millions to risk in the development of trade is not too much to expect from a government that has always stood for constructive statesmanship."

Lieut. Fred Clarke, who for the past few years has been connected with the contracting firm of Grant, Smith & McDonnell, of Vancouver, is now organizing a railroad construction draft for overseas duty.

Mainly Constructional

East and West—From Coast to Coast

The Military Hospital Commission, according to report, has a scheme under way for the erection of a $300,000 hospital in London, Ont., for that military district. The Ontario Government is to be asked for a grant of twenty acres from property of the London Hospital for the Insane, fronting on Dundas Street.

It is possible that the Bloor Street viaduct, Toronto, may be completed and ready for traffic before winter sets in this year. Works Commissioner Harris has been instructed to confer with the contractors with a view to obtaining their consent to allow the city to proceed with the pavement concurrently with the progress of construction.

The Toronto Board of Control recently received from the Parks Commission and the works commissioner the plans for the reclamation work proposed to be undertaken this year by the Harbor Commission at the western channel, Island Park, Hanlan's Point, and Keele Street, the total estimated expenditure amounting to $367,400.

At the last meeting of the Town Council of Lindsay, Ont., Mr. Oliver Smith, the town engineer, presented a report, prepared by James, Loudon & Hertzberg, of Toronto, on the location and size of the proposed storm sewer to drain the Dominion Arsenal area. It is proposed to build a sewer, beginning with a 30-inch diameter and finishing with a 48-inch diameter, on Albert Street and Melbourne Street. The total length of sewer is about 2,800 feet.

The Canadian Leonard Construction Co. are taking rapid steps in preparation for the erection of the new Quaker Oats plant at Peterboro, Ont., which is to be put under way very shortly. A tower for the elevation of concrete is being built, and will first be used in the construction of 18 new concrete silos for the storage of grain. These silos will be similar to those which were previously in use and which escaped the fire. The demolition of the six-storey warehouse is proceeding. The rear portion was levelled by blasting, and the front end is being taken down from the top. It is the intention of the company to have the eight-storey building, comprising the main portion of the plant, up by Christmas, together with the new battery of grain storage elevators. A large boarding and rooming house for accommodating the men is nearing completion.

Improvements in London, Ont., and London district that will cost over $300,000, it is stated, will be undertaken immediately by the C.P.R. The work will be rushed, so that by fall the company will be in a position to put its newest and largest locomotives on the lines between Windsor and Toronto to handle what is expected to be the greatest business on record. More than $200,000 will be expended between London and Toronto in rebuilding the bridges, so that they will carry the heavier trains, and all the principal sidings in the district are to be enlarged, so that they will accommodate longer trains. The entire system between London and Windsor will be reballasted this summer, at a cost of $75,000. The station at London is to be remodelled and larger express and baggage rooms built and a new lunch room installed. These improvements, together with new heating, etc., will cost over $10,000.

The delegation from the North Vancouver district, which recently visited Ottawa to present their claims regarding the nationalization of Vancouver harbor and government aid for the construction of a dry-dock, were informed by Hon. R. Rogers, Minister of Public Works, that the Dominion subsidy in connection with dry-dock work was open to the first company which could comply with the government's requirements. The Minister also stated that he proposed bringing in a bill to increase the subsidy for a first-class dock to 4½ per cent. It is now reported that the Peter Lyall & Sons Construction Company, of Montreal, are likely to take advantage of the government assistance, and that they have secured an option for the purchase of the new Wallace shipyards No. 2 and the Fell property adjoining. It is understood that the plans under consideration include not only a considerable enlargement of the present shipyards, but later the construction of a large dry-dock on the adjoining foreshore.

The Sarnia Builders' Exchange has taken out letters patent of incorporation under the Ontario Companies Act, without share capital. The objects of the exchange, as set forth under their incorporation, are as follows: To promote and protect the interests of those engaged in the various trades and occupations connected with the construction and erection of buildings in the County of Lambton, and especially in the city of Sarnia; to establish and maintain uniformity in commercial usages relating to building and building trades; to secure and furnish to its members information on matters pertaining to their business interests; to prevent, as far as possible, and to adjust difficulties and misunderstanding in relation to said occupations; to inculcate just and equitable principles, and to promote good feeling and harmony amongst those engaged in the various building trades and other kindred trades. The provisional directors of the exchange are George A. C. Andrew and James Harrison Shanks, builders; Norris Elgin Gibb and John Elnor, carpenters; Joseph Gravelle, painter; John McGibbon, lumber merchant; and Harry Bailey Fenton, manufacturer, all of the city of Sarnia. Active steps will be taken at once to provide more houses in the city, and it is the intention of the association to canvass the city in the endeavor to obtain stock subscriptions for approximately $100,000 to be used in the erection of workingmen's homes. The exchange would finance the construction of homes to reliable parties, the cost to be paid in regular monthly instalments, according to the tentative plan projected at a recent meeting.

Personals

Mr. S. B. Bennett, formerly municipal engineer of South Vancouver, has been appointed principal of engineering and allied trades at the Winnipeg college for returned soldiers.

Major E. G. M. Cape, president of E. G. M. Cape, Ltd., general contractors, Montreal, is among the officers returned to Canada from the front on sick leave. Major Cape was recently wounded.

John D. Galloway, assistant mineralogist in the Department of Mines at Victoria for several years, has been appointed engineer for the Northeastern Mineral Survey District, which embraces the old mining divisions of Omineca, Peace River, Cariboo, and Quesnel. Mr. Galloway, whose headquarters will be at Hazelton, is a graduate of McGill University. The new mining act divides the province into six districts, each to be in charge of a qualified engineer, but it is thought no further appointments will be made for some time.

Mr. Frank H. Crockard has been elected president of the Nova Scotia Steel and Coal Company, in succession to Col. T. Cantley, who becomes president of the board of directors. Mr. Crockard was formerly vice-president of the Tennessee Coal, Iron, and Railroad Company, in active charge of construction and co-operation. This concern is a subsidiary of the United States Steel Corporation. Mr. Crockard, it is officially announced, intends to devote his time to developing plans for the enlargement of the company's steel and coal-producing capacity. This expansion will be confined to Newfoundland and Canada.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Copper Cliff, Sask.
The Canadian Copper Company will purchase cement, brick, asbestos roofing, two or three centrifugal pumps and pipes in connection with the erection of their $20,000 sewage pumping station.

East Oxford Township, Ont.
Township Council contemplate road repairs, culvert repairs and new bridge. Clerk, J. G. Jackson, Oxford Centre.

Edmundston, N.B.
Town Council contemplate addition to aqueduct, sewage, and electric systems, costing $75,000.

Lindsay, Ont.
The town proposes to build a sewer, beginning with a 30-inch diameter and finishing with a 48-inch diameter on Albert and Melbourne Streets. Total length 2,800 feet. James, Louden & Hertzberg, Toronto, consulting engineers.

London, Ont.
The Utilities Commission contemplate water extension. Chairman, E. V. Buchanan.

Montreal, Que.
The Board of Control will purchase brick for construction of sewers.

Oil Springs, Ont.
Town Council contemplate drainage repairs. Councillors, Dewar and Hutchinson.

Warwick Township, Ont.
Township Council contemplate drainage work. Secretary-treasurer, N. Herbert, Watford.

Weston, Ont.
Plans are being prepared by the consulting engineers, James, Loudon and Hertzberg, and tenders will be called in the near future for a reinforced concrete intake crib, concrete dividing wall in the sedimentation basin, and for lining the basin with concrete.

CONTRACTS AWARDED

East Wawanosh, Ont.
Mr. Logan, care of Clerk, A. Porterfield, Belgrave, has general contract for drainage system for the Township Council.

Marieville, Que.
Mr. Coderre, St. Eusebe, has general contract for cement walks costing $10,000, for the city.

Railroads, Bridges and Wharves

Benmiller, Ont.
Plans and specifications at office of the clerk, R. McIlwain, Nile, who will receive tenders until June 30 for the construction of two cement abutments for Pfrimmer Bridge for the Township of Colborne.

Florenceville, N.B.
Tenders received at the Department of Public Works, Provincial Government, until noon, July 4, for the construction of a steel bridge, 1 span, 56 feet long, concrete piers and abutments. Plans and specifications at the Department of Public Works. Minister, P. J. Veniot.

Kingston, Ont.
Tenders received until July 16 for the reconstruction of part of the cribwork wharves at entrance to dry dock for the Department of Public Works, Dominion Government. Plans and specifications at office of District Engineer, Equity Bldg., Toronto, and Postmaster, Kingston. Secretary, R. C. Desrochers, Ottawa.

London, Ont.
London & Port Stanley Railway Board contemplate construction of sidings. Secretary-treasurer, Lt.-Col. Spittal, Peoples Building Company.

Moncton, N.B.
Tenders have been received for the erection of bridges, substructures and concrete culverts on the Intercolonial Railway for the Department of Railways & Canals, Dominion Government.

CONTRACTS AWARDED

Metcalfe Township, Ont.
R. Waltham, care of Township Clerk, Harry Thompson, Kerwood, has the general contract for two reinforced concrete bridges for the Township Council.

Newbury, Ont.
McPherson & Clerk, Glencoe, have general contract for station and freight sheds, costing $5,000, for the Grand Trunk Railway, head office, Montreal.

Potton Township, Que.
Alex. Pellerin, Farnham, has the general contract and McKinnon, Holmes & Co., Sherbrooke, the steel contract for $3,900 concrete and steel bridge for the Township Council.

St. Ulric, Que.
O. H. Morin, Sandy Bay, has general contract and will sub-let steel for $8,756 concrete and steel bridge for the Municipal Council.

Wellington County, Ont.
The County Council have awarded the contracts for bridges as follows:—E. Simons, Drayton, one; C. Smith, Hillbury, two; Mallini & Langdon, Fergus, two.

West St. John, N.B.
Grant & Horne, B.N.A. Building, have general contract for $15,000 engine shed for the Canadian Pacific Railway, head office, Montreal, and are in the market for cement, lumber, and metal lath.

Public Buildings, Churches and Schools

Campbellford, Ont.
The Town Council have decided to go ahead with installation of modern plumbing for the Public and High School and to lay a sewer to the River. Plans are being prepared and tenders will be called in the near future. James, Loudon and Hertzberg are the engineers retained by the town.

Cardston, Alta.
Tenders are being received by the chairman of the building committee, William Duce, First Avenue E., for the erection of a $20,000 brick and cement church. Plans and specifications with H. D. Folsom, First Street N.

Hamilton, Ont.
Ebenezer Hall, Barton and Ruth Sts., contemplates erection of a church.

Kentville, N.S.
Tenders received by the commissioner, Hon. E. H. Armstrong, Halifax, until noon, June 30, for the erection of an infirmary for the Provincial Government. Plans and specifications at office of the commissioner and sanitorium.

London, Ont.
Plans in progress for a $20,000 brick nurses' home for the London Health Association. President, Sir Adam Beck.

Notre Dame du Laus, Que.
School Board will start shortly on the erection of a frame school. Secretary-treasurer, S. Charette, Lac-a-Foin.

Pincher Creek, Alta.
Municipal Council contemplate erection of hospital this year. Address, Mayor and Hon. W. Gariepy, Pauls Bldg., Edmonton.

Sydney, N.S.
Plans and specifications with the county clerk, James McNeil, until June 30, for $10,000 asbesto slate roof for asylum for the County of Cape Breton.

Verdun, Que.
Verdun Baptist Church are erecting a $5,000 addition. The architect, Sydney Coomber, Drummond Bldg., Montreal, is receiving sub-tenders for roofing, heating, plastering, plumbing and electrical work.

Westminster Township, Ont.
Township Council contemplate $5,000 school. Secretary-treasurer, Geo. Riddell, Wilton Grove.

CONTRACTS AWARDED

Charlesburg, Que.
Ernest Paradis has general contract for $5,000 brick and frame school for the School Board.

Edmonton, Alta.
Mr. Jeffries, 212 McLeod Bldg., has

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